Special Technical Report 40

FURTHER EVALUATION OF FREQUENCY PREDICTIONS FOR SHORT-PATH RADIO COMMUNICATIONS IN THAILAND

By: VICHAI T. NIMIT

Prepared for:

U.S. ARMY ELECTRONICS COMMAND
FORT MONMOUTH, NEW JERSEY 07703

CONTRACT DA 36-039 AMC-00040(E)
ORDER NO. 5384-PM-63-91

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA

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SRI Project 4240

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ABSTRACT

Predictions derived by two methods for estimating F-layer critical frequency are evaluated by comparing 1967 predictions and measurements for Bangkok. One set of predictions has been obtained from a program developed at SRI (SRI/RPA predictions); the other has been obtained by scaling prediction contour maps prepared by ESSA. The SRI/RPA predictions have been corrected to take into account the error in prediction during 1966 compared to measurements at Bangkok, but because of a modification in ESSA predictions, including those for Southeast Asia, no local correction has been applied to 1967 ESSA predictions. Thus, for 1967 corrected SRI/RPA and uncorrected modified ESSA predictions are evaluated. The evaluation shows that the average error of both predictions of foF2 relative to ionosonde measurements is less than 1 MHz. The modified ESSA predictions are somewhat more accurate, averaging about 0.5 MHz higher than the observed median foF2 values.

A comparison of uncorrected modified ESSA predictions for 1967 and ESSA predictions for previous years shows a definite improvement in accuracy of these uncorrected modified ESSA predictions relative to the uncorrected predictions made prior to 1967. Based on 1967 results, it is expected that future uncorrected ESSA predictions will be at least as accurate as SRI/RPA predictions that have been corrected using local Bangkok C-2 data. Furthermore, the anticipated error in uncorrected ESSA predictions (about 0.5 MHz average) is not serious enough to warrant applying a local correction for the vicinity of Bangkok. Consequently, the 3-month-term ESSA predictions would be preferred for Thailand.

CONTENTS

ILLUSTRATIONS

PREFACE

The work described in this report was performed with the support, and using the facilities, of the Military Research and Development Center (MRDC) in Bangkok, Thailand. The MRDC is a joint Thai-U.S. organization established to conduct research and development work in the tropical environment. The overall direction of the U.S. portion of the MRDC has been assigned to the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense, which, in 1962, asked the U.S. Army Electronics Command (USAECOM) and the Stanford Research Institute (SRI) to establish an electronics laboratory in Thailand to facilitate the study of radio communications in the tropics and related topics. The MRDC-Electronics Laboratory (MRDC-EL) began operation in 1963 [under Contract DA 36-039 AMC-00040(E)], and since that time ARPA has actively monitored and directed the efforts of USAECOM and SRI. In Bangkok, this function is carried out by the ARPA Research and Development Field Unit (RDFU-T). The cooperation of the Thai Ministry of Defense and the Thailand and CONUS representatives of the ARPA and USAECOM made possible the work presented in this report.

The regular monthly predictions of the U.S. Environmental Science Services Administration (ESSA) were used in this study. ESSA also makes special (local area) predictions for Southeast Asia, which are available in the form of numerical-map coefficients on the same schedule as the regular world-wide predictions. Both sets of predictions are issued as card decks suitable for use with a modern high-speed electronic computer. These special predictions are believed to be more accurate than the regular predictions, but they should be checked against measured data. Unfortunately, these predictions were not available to the author of this report at the time of his study; however, they are currently available on a subscription basis from: Prediction Services, Institute for Telecommunications Sciences, ESSA, Boulder, Colorado 80302,

Attn: Mrs. M. Leftin. Also, semimonthly revision factors for the regular monthly predictions are derived by a subjective extrapolation of current trends of solar and ionospheric data, and these are available from the above address about one week before the half-month of application. These short-term corrections could also be checked for Bangkok in a future study.

ACKNOWLEDGMENTS

The author is pleased to acknowledge the helpful comments and suggestion of Mr. S. M. Ostrow and Mr. C. L. Rufenach of ESSA, Boulder, on a draft of this report. The author also wishes to acknowledge the encouragement and help of his colleagues at SRI, Menlo Park, in particular Mr. H. W. Parker and Mr. G. H. Hagn for their support and contributions to the preparation of this report.

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I INTRODUCTION

For short-path radio communication via skywave, the F2 layer critical frequency for the ordinary wave (foF2) is a good measure of the maximum usable frequency (MUF). The Institute of Telecommunication Sciences (ITS) of the Environmental Science Services Administration (ESSA)* and Stanford Research Institute (SRI) have developed electronic computer programs for prediction of F2 critical frequency. The ESSA predictions are made on a regular basis for all parts of the world. These predictions are made as numerical-map coefficients of predicted monthly median foF2 and M(3000)F2. From these coefficients ESSA derives worldwide contour maps[1]+ of zero-km (fxF2) and 4000-km F2-layer maximum usable frequency. The maps are based on measurements of critical frequency at ionospheric observatories throughout the world. The predictions are issued on a monthly basis and are available three months in advance. The SRI prediction program, developed for the U.S. Army Radio Propagation Agency (RPA), is very useful for long-term predictions.[2,3] SRI/RPA predictions are not made on a regular basis, but were generated for the location of Bangkok, Thailand for use on the Advanced Research Projects Agency's SEACORE program.

To facilitate more accurate critical frequency predictions for tropical areas like Thailand, studies have been made to evaluate past predictions. In the first study, measurements made by a C-2 vertical-incidence sounder located at the MRDC-Electronics Laboratory in Bangkok were compared with ESSA and SRI/RPA predictions for the period of September 1963 to March 1965. A median error function was derived for each prediction method, and these error functions were used to correct ESSA and SRI/RPA predictions for April 1965 through December 1966.[4]

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*Formerly the Central Radio Propagation Laboratory (CRPL) of the National Bureau of Standards (NBS).

+References are listed at the end of the report.

In a later study, C-2 measurements were compared with the uncorrected and the corrected ESSA and SRI/RPA predictions for April 1965 through December 1966. The evaluations showed that the corrected predictions were substantially better than the uncorrected ones for both the ESSA and the SRI/RPA predictions and that the corrected ESSA predictions were the best.[5] A new correction function based on data for April 1965 through August 1966 was derived and applied to SRI/RPA predictions for 1967. A local correction function for 1967 ESSA predictions was not derived because of a modification in ESSA predictions, including those for Southeast Asia.* These modified ESSA predictions† incorporate recent Bangkok C-2 data; and by coincidence, January 1967 was the first month when this occurred.

The first purpose of this report is to compare 1967 measurements at Bangkok with the corrected SRI/RPA predictions and the uncorrected modified ESSA predictions. A second purpose is to study the trend in accuracy of ESSA predictions and to examine the effectiveness of correcting these predictions by applying a correction equal to the error between predictions and measurements for the previous year. A third objective is to determine whether it is desirable to correct the 1968 modified ESSA predictions for Bangkok--that is, whether the 1967 modificiation reduced ESSA prediction error to a level where further refinement is not justified.

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*Beginning with January 1967, ESSA began using a modified magnetic dip angle coordinate system rather than a geographical coordinate system for the determination of the coeffeicients used in the numerical mapping technique.[6]

†"Modified ESSA prediction" is used throughout this report to refer to the uncorrected modified ESSA predictions for foF2, as distinguished from the pre-1967 ESSA predictions. These uncorrected modified ESSA predictions were obtained by scaling the worldwide contour maps of fxF2 for Bangkok and subtracting 0.5 MHz to obtain an estimate of foF2 (the gyrofrequency at ionospheric heights over Bangkok is about 1.0 MHz).

II SRI/RPA AND MODIFIED ESSA PREDICTIONS FOR 1967

A. DATA SOURCE

The observed monthly median foF2 values were taken from the monthly published ionospheric data reports.[7,8] The predicted monthly median foF2 values were taken from Ref. 5 for the corrected SRI/RPA predictions and from Ref. 1 for the modified ESSA predictions.

B. COMPARISON

To facilitate the comparison of monthly median foF2 data, both the predicted and observed values were plotted as functions of time. A typical comparison plot is given in Fig. 1, showing data for January 1967. The upper plot shows the corrected SRI/RPA prediction, the uncorrected modified ESSA prediction, and the observed monthly median. The lower plot shows the error function for each prediction, obtained by taking the difference between the predicted and observed values. Notice that a positive prediction error indicates that the predicted frequency was greater than that observed. Predicted and observed data for the rest of 1967 are compared in Figs. 2 through 12.

C. EVALUATION

The prediction error curves in Figs. 1 through 12 show that the SRI/RPA predictions were generally too low, that the modified ESSA predictions were generally too high, and that the magnitude of error varies substantially during the year. To aid in evaluating the effectiveness of the predictions, the median and the quartile range of the monthly error functions were calculated for the entire year for twelve points in the 24-hour period. The results are shown in Fig. 13. The SRI/RPA prediction error varies from -0.5 MHz in the early morning hours to -1.3 MHz in the daytime and has an average value of -0.9 MHz. The ESSA prediction error varies from about zero to 1.0 MHz during the day and night and has an average value of 0.5 MHz. The quartile range of the

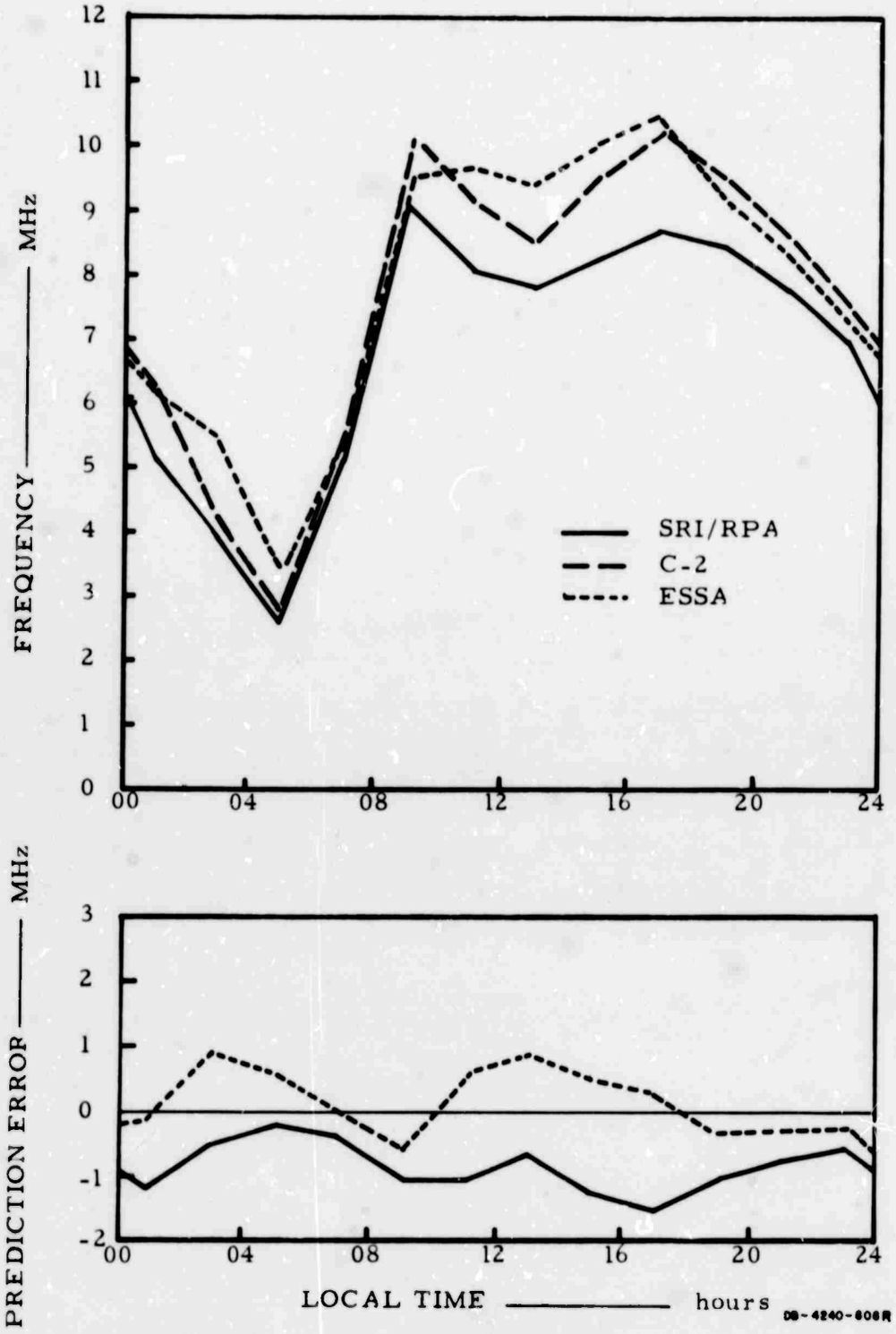

FIG. 1 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR JANUARY 1967

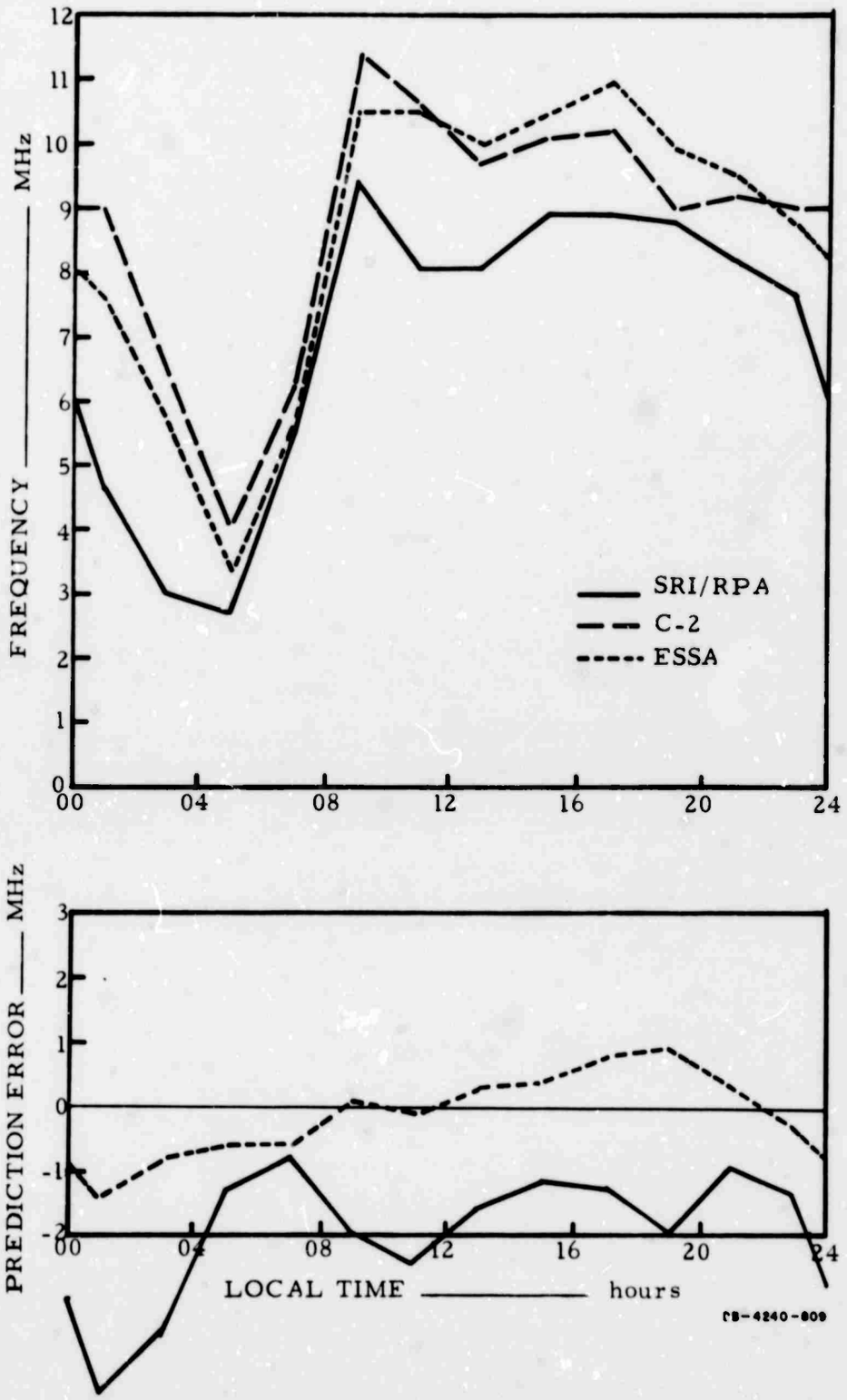

FIG. 2 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR FEBRUARY 1967

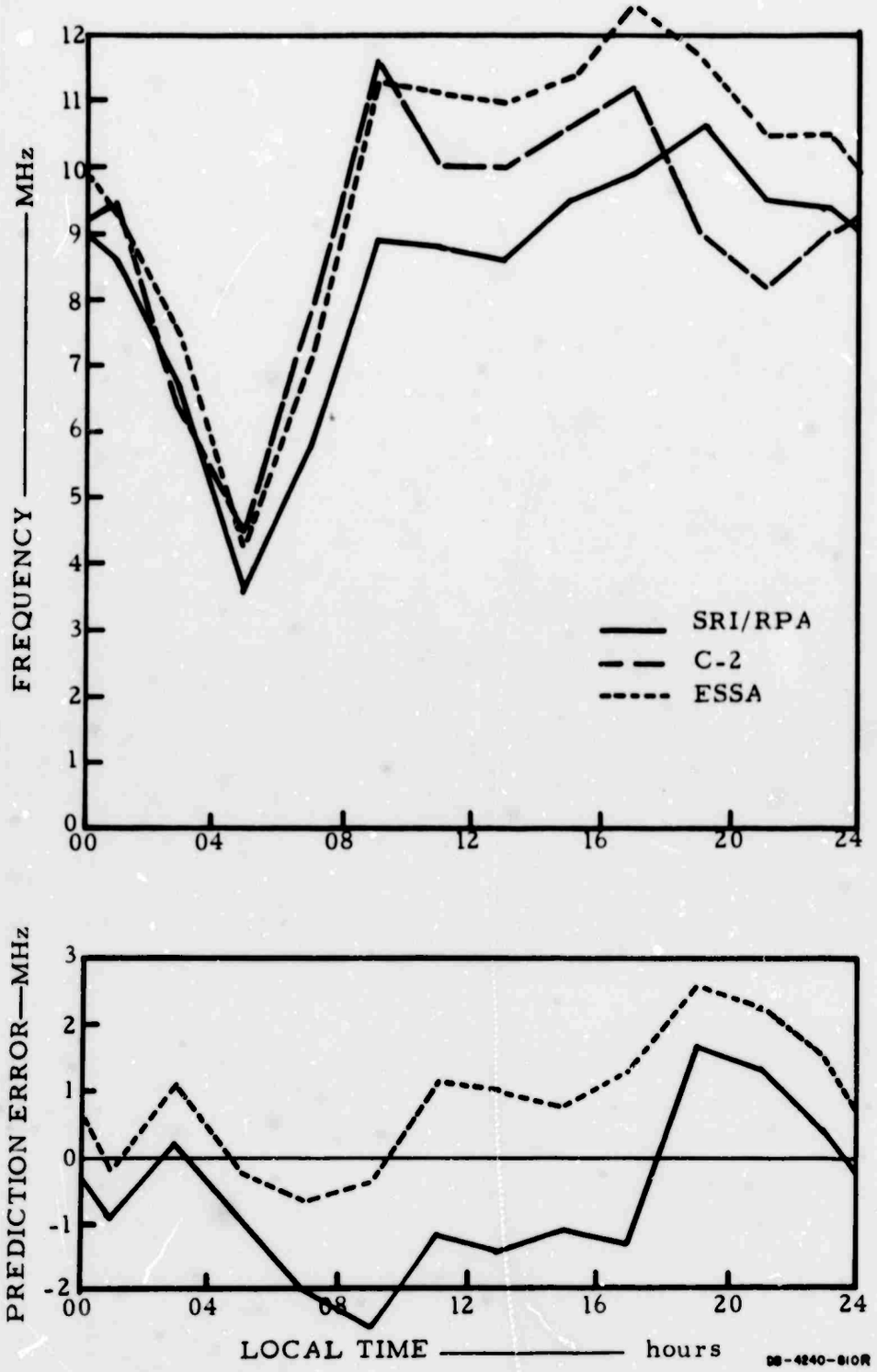

FIG. 3 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR MARCH 1967

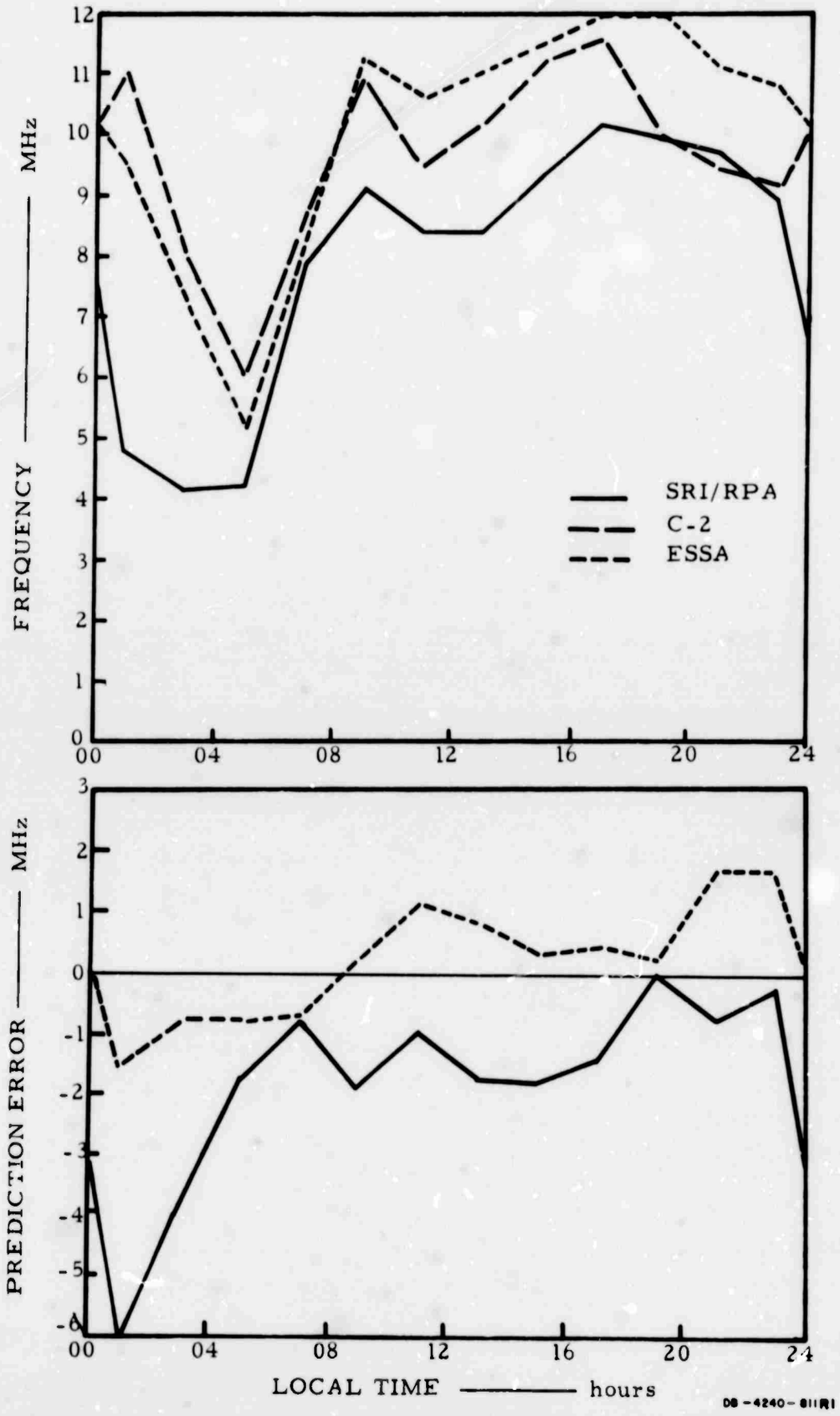

FIG. 4 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR APRIL 1967

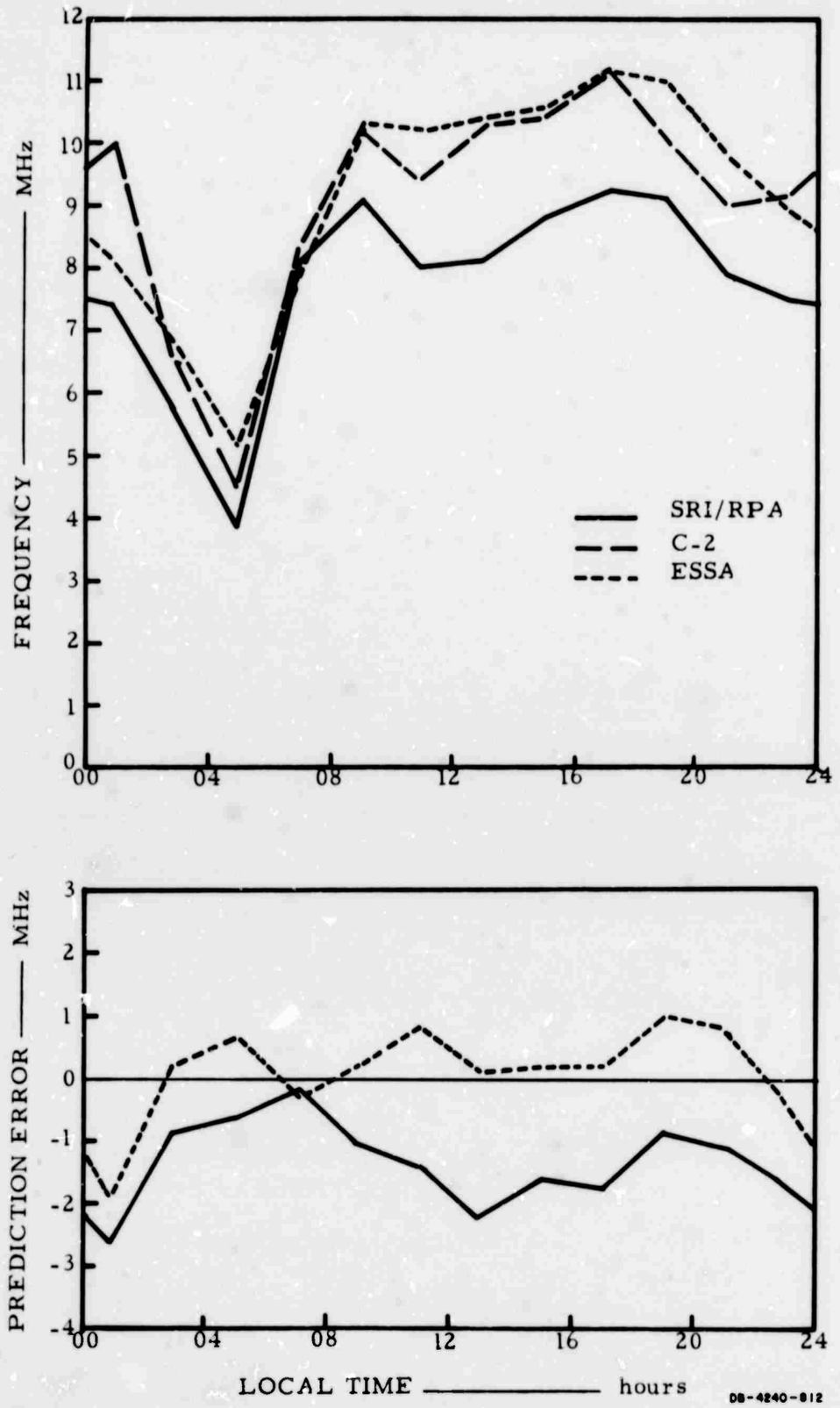

FIG. 5 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR MAY 1967

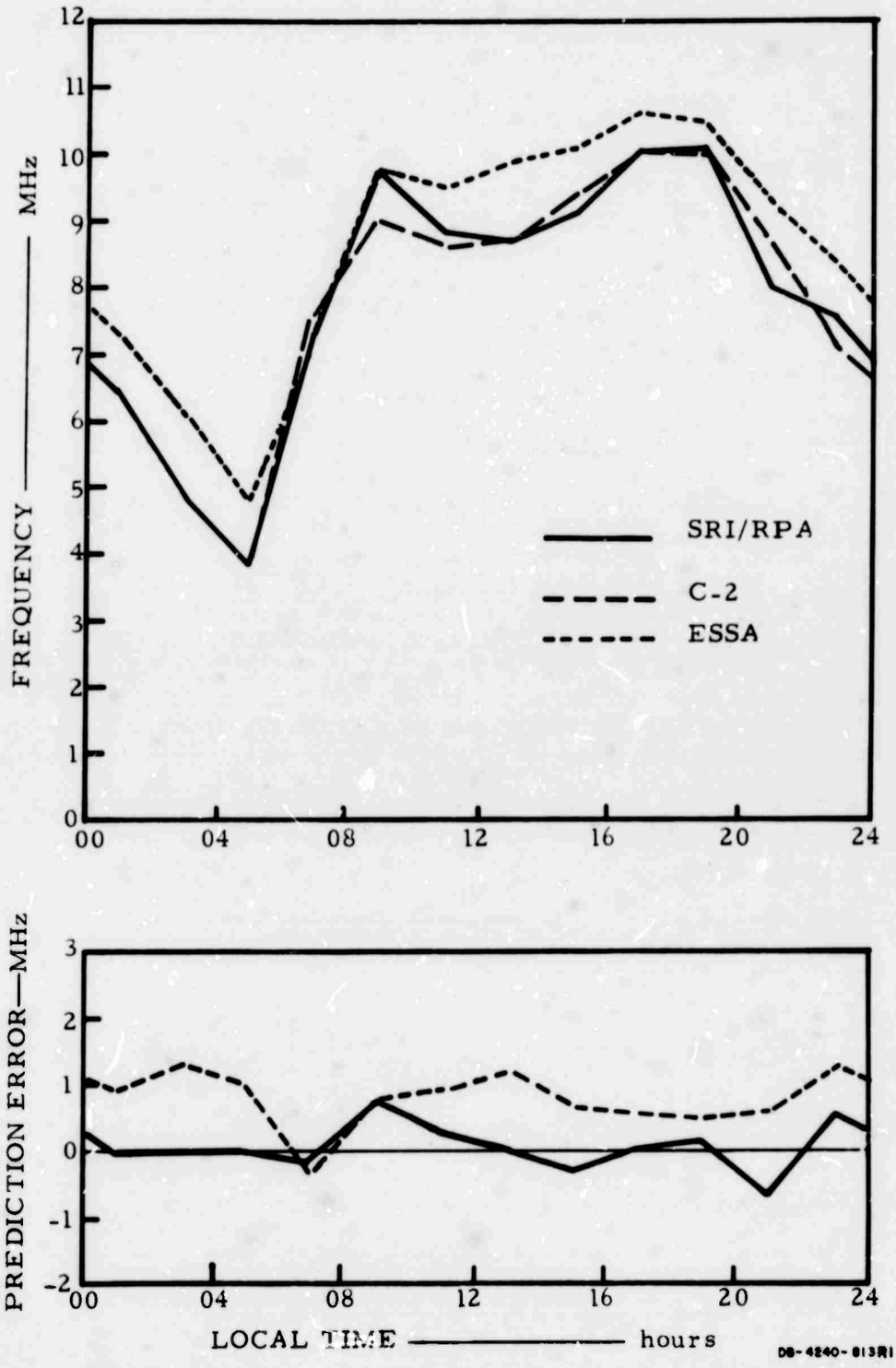

FIG. 6 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR JUNE 1967

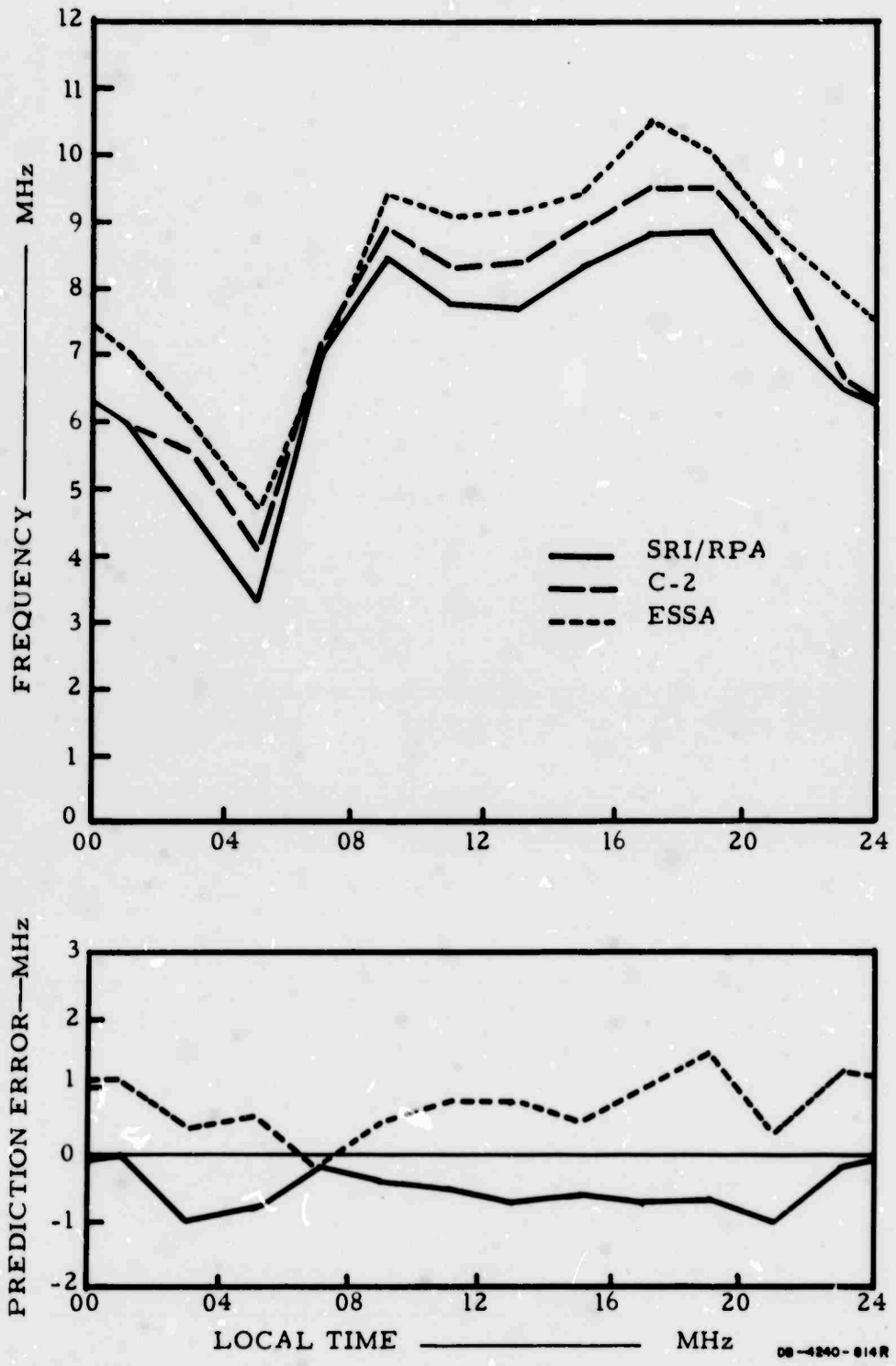

FIG. 7 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR JULY 1967

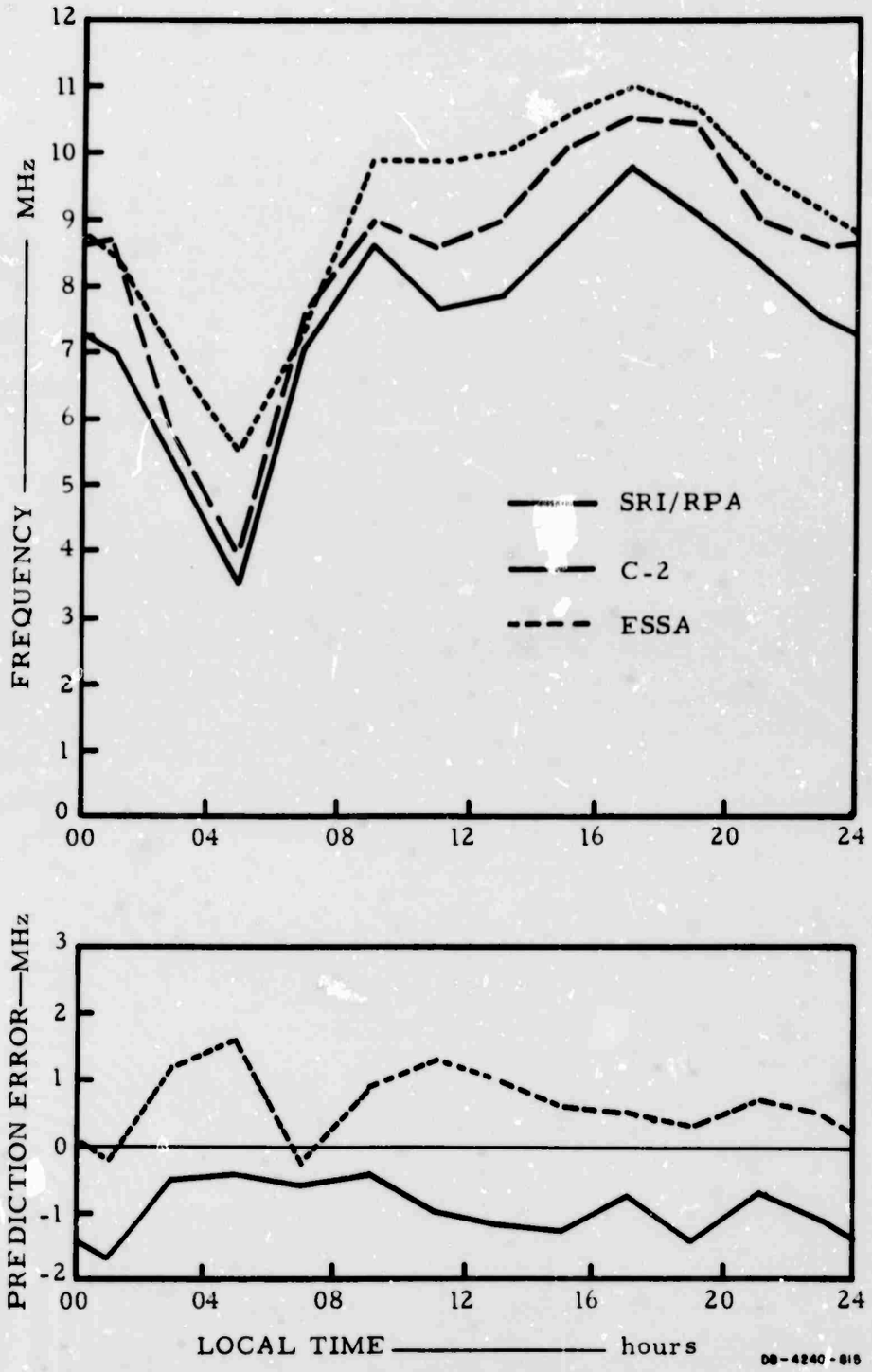

FIG. 8 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR AUGUST 1967

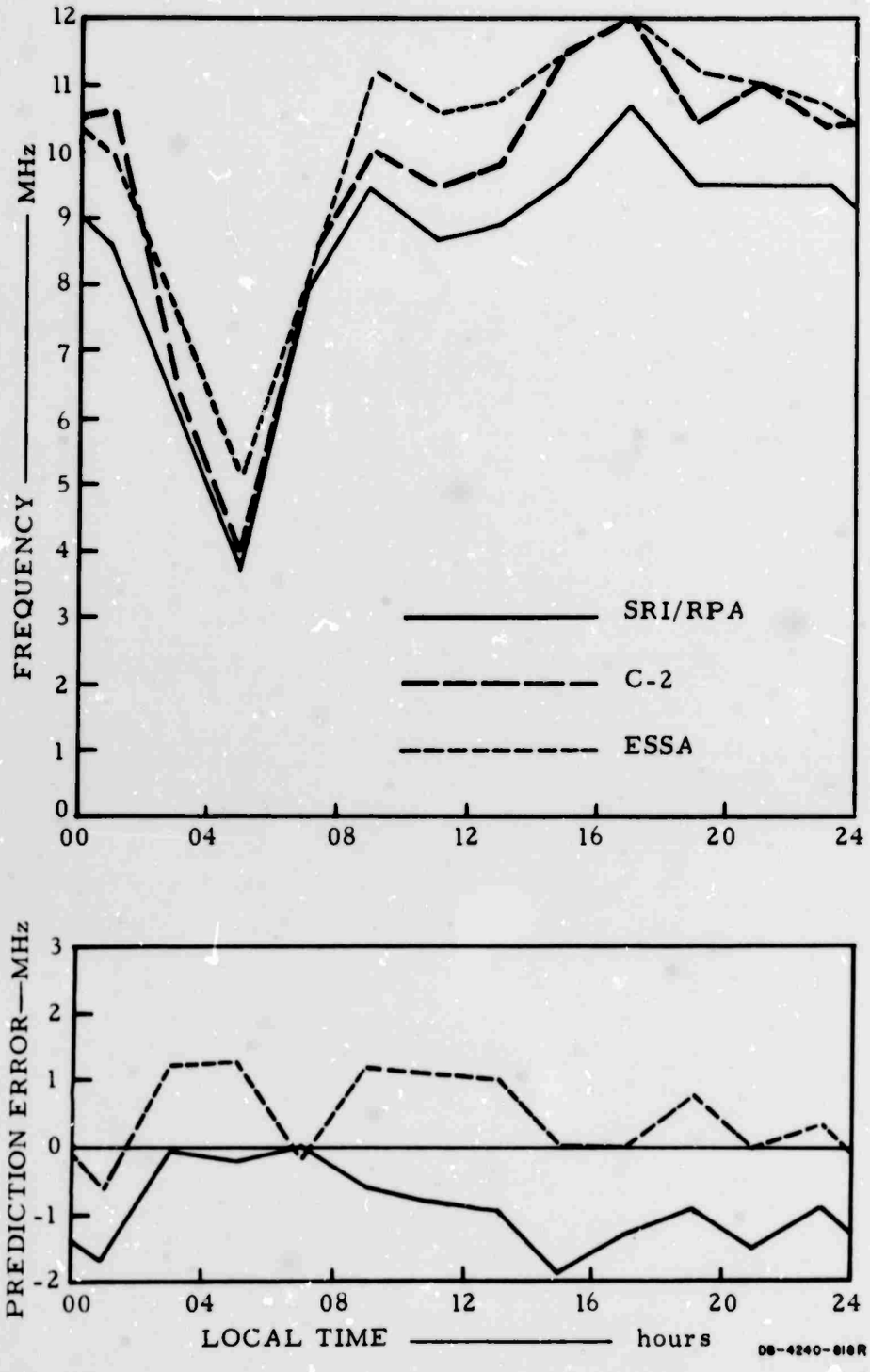

FIG. 9 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR SEPTEMBER 1967

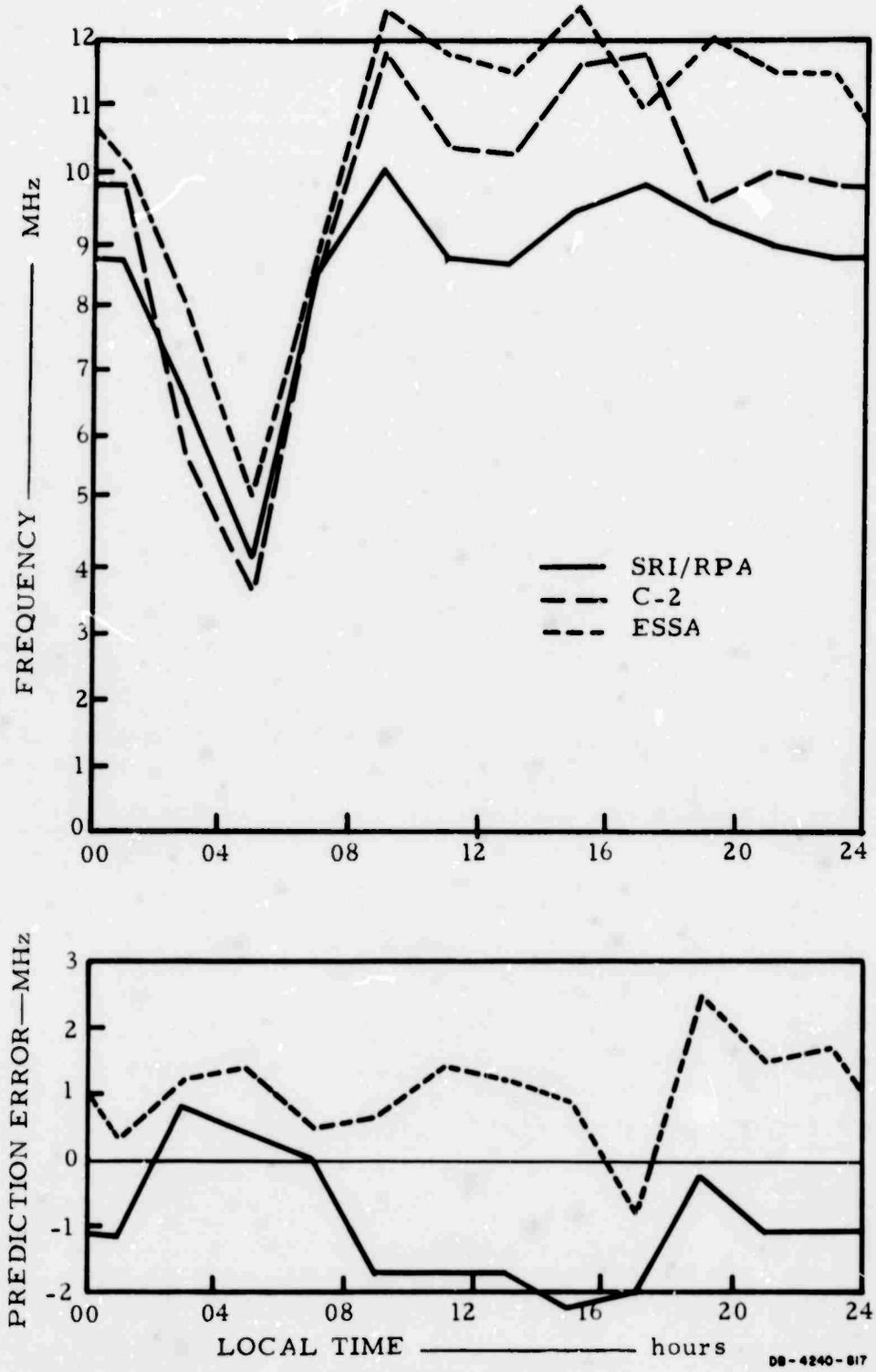

FIG. 10 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR OCTOBER 1967

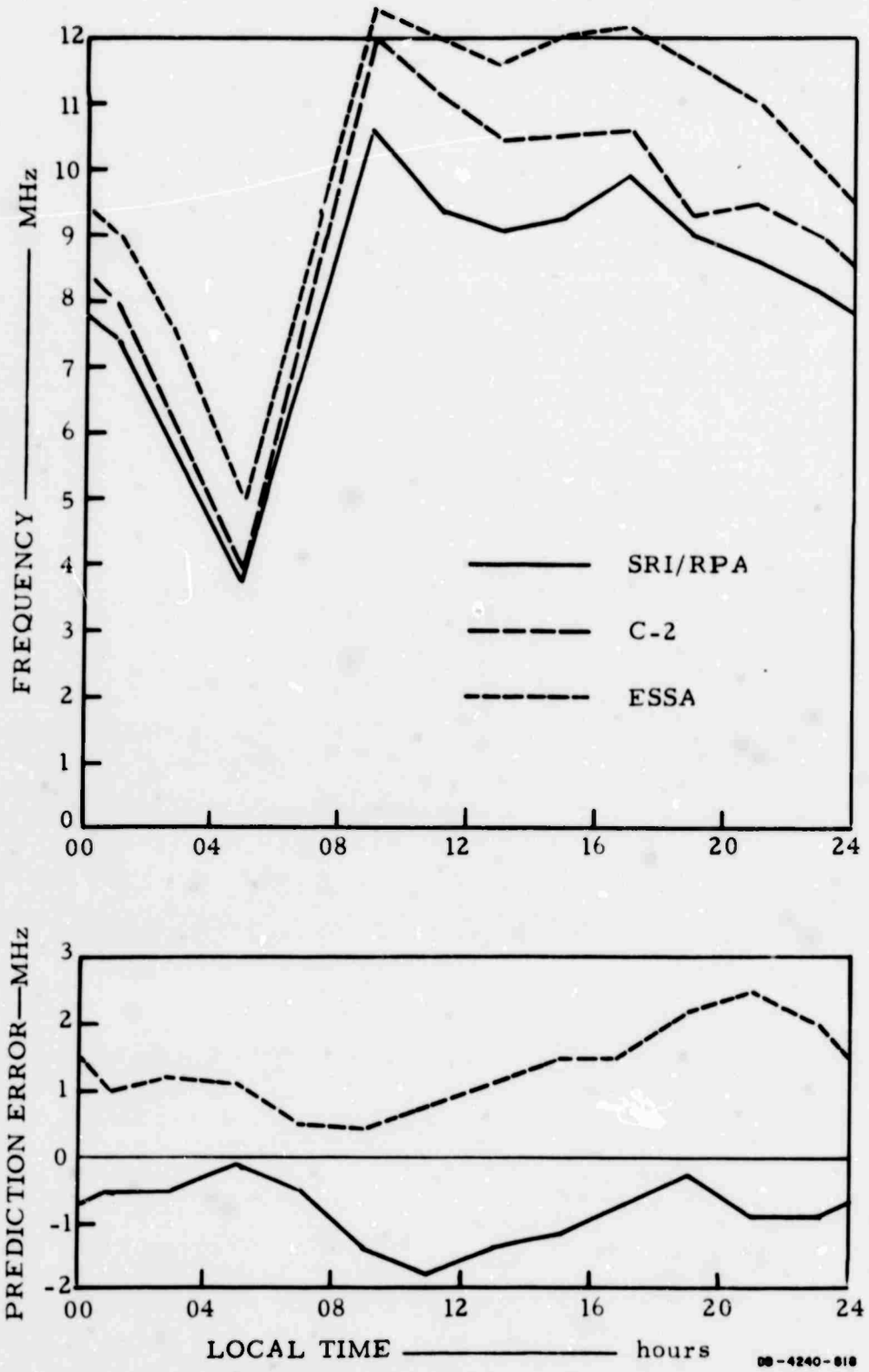

FIG. 11 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR NOVEMBER 1967

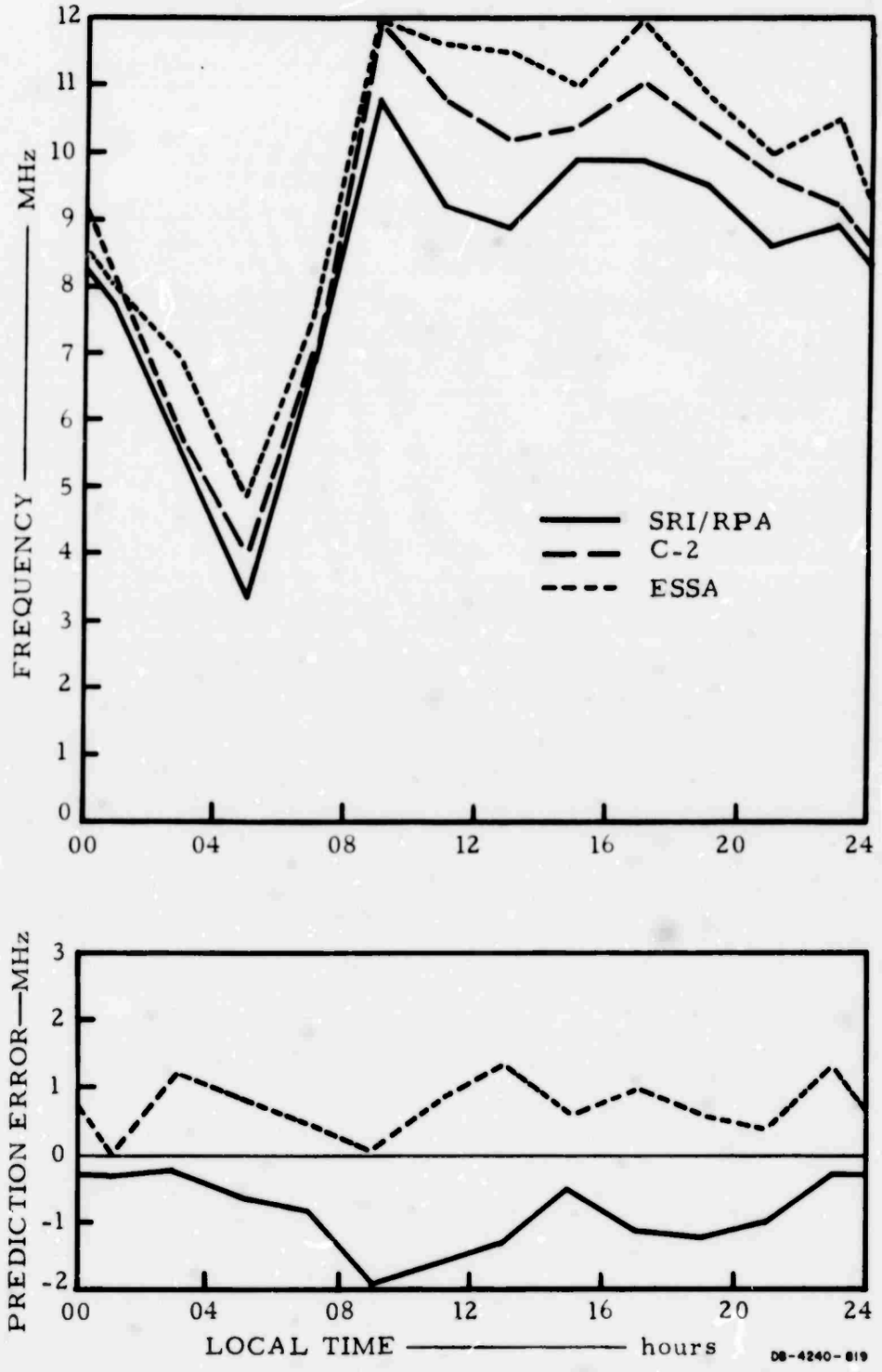

FIG. 12 COMPARISON OF OBSERVED AND PREDICTED MONTHLY MEDIAN foF2 AND ERROR FUNCTION FOR DECEMBER 1967

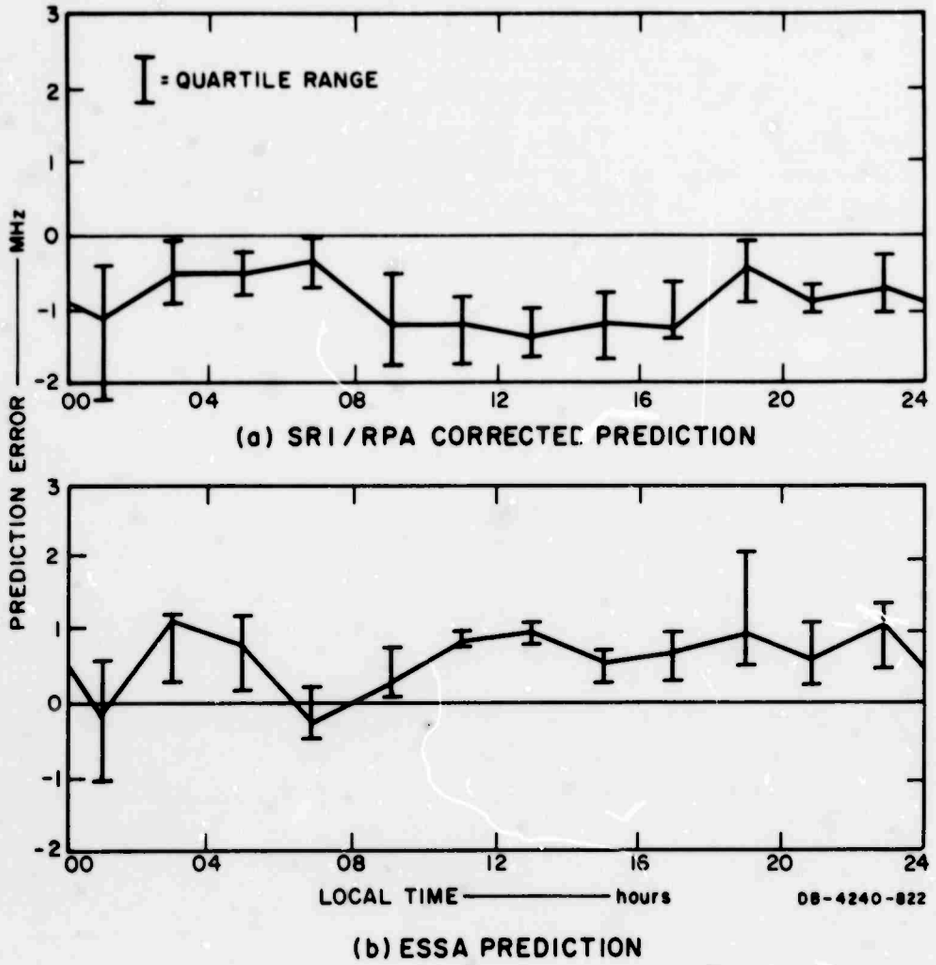

FIG. 13 COMPARISON OF MEDIAN ERROR FUNCTIONS FOR 1967

prediction error is smaller for ESSA than for SRI/RPA from about 0900 to 1500 hours LT, but when the quartile ranges are averaged over the day and night, there is no significant difference in the spreads of the prediction errors from the two predictions. Since the average of median errors is smaller for ESSA and the quartile ranges of error are similar for both prediction methods, it appears that the uncorrected ESSA predictions are somewhat better than the corrected SRI/RPA predictions. However, both prediction methods are reasonably accurate and either one is adequate for most prediction purposes.

III ESSA PREDICTIONS FOR 1964-1967

Of the many techniques deveoped for frequency prediction,[9-21] those of ESSA and SRI/RPA were chosen for estimating the probability of successful skywave communication in Thailand. Pre-1967 comparisons indicated that the corrected ESSA predictions were more accurate than the corrected SRI/RPA predictions,[4,5] and the present study of 1967 data indicates that the uncorrected modified ESSA predictions were somewhat better than the corrected SRI/RPA predictions. Furthermore, this study implies that the modified ESSA predictions might be accurate enough for use in Thailand without correction. Therefore, it was decided to look in some detail at the ESSA predictions for the entire period when C-2 data for Bangkok was available, in order to determine the year-to-year variation of effectiveness of these predictions.

The comparison of predicted and observed values of critical frequency was made as described in Sec. II-B. The comparison curves may be examined in detail in the following sources:

1964--Reference 4, Appendix A, Figs. A-1(e) to A-1(p)

1965--Appendix A of the present report

1966--Appendix B of the present report

1967--Section II of the present report, Figs. 1-12.

Because of the variance in monthly median values, the prediction error is more useful if averaged over a longer period; thus, the medians and quartiles of the monthly median error for each year were compiled. The yearly medians and quartile ranges for 1964 through 1967 are shown in Fig. 14. The average yearly prediction errors were quite similar in 1964, 1965 and 1966, as were the quartile ranges. The effect of the 1967 modification to the ESSA prediction technique was to reduce the error and its quartile range for the daylight hours. The improvement in ESSA predictions in 1967 is easily seen in Fig. 15, which shows the yearly medians of the monthly median errors for 1964-1967.

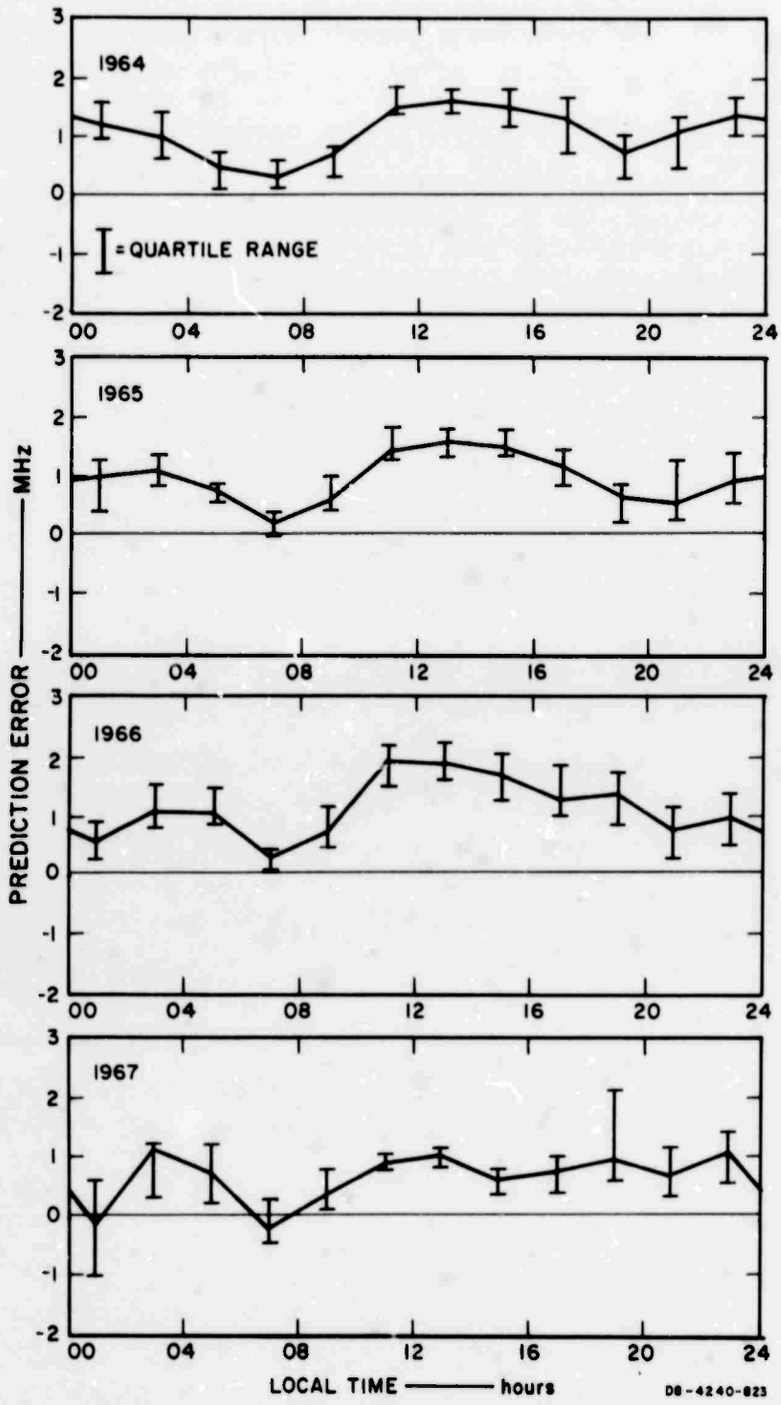

FIG. 14 MEDIAN AND QUARTILE VALUES OF ERROR FUNCTIONS OF ESSA foF2 PREDICTIONS FROM 1964 THROUGH 1967

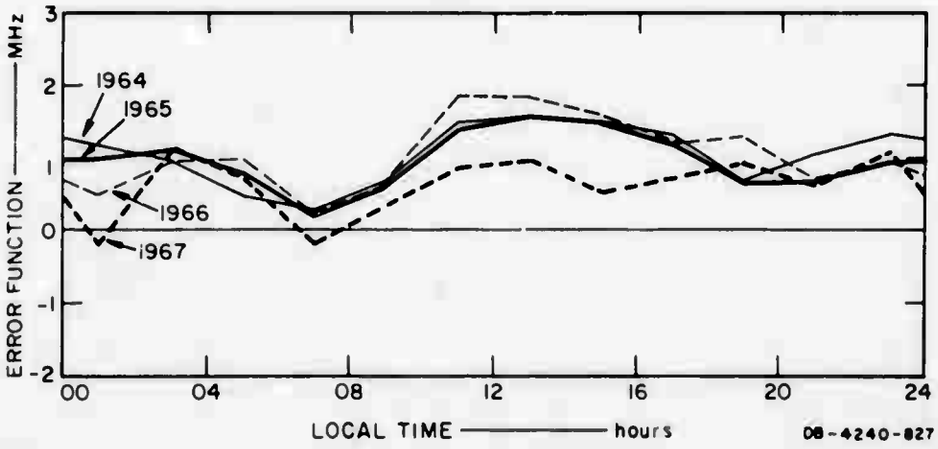

FIG. 15 COMPARISON OF MEDIAN ERROR FUNCTIONS FOR 1964 THROUGH 1967 ESSA foF2 PREDICTIONS

The prediction error obtained by comparing prediction and measurement for one year can be used to correct the prediction for the following year, provided that no significant modification has been made in the generation of predictions. For example, the median error function for 1964 becomes the correction function for 1965. Correction functions for 1965, 1966 and 1968 are shown in Fig. 16. (A correction function for 1967 is not shown because the 1966 error function is not a valid correction for the "modified" 1967 predictions.)

Corrected monthly median predictions can be obtained by subtracting the correction function from the original predictions. In practice, the correction was made for each two-hour interval of the day and night, with the time of the corrected points being determined by the time of C-2 ionosonde measurements. Corrected monthly predictions for 1965 and 1966 are shown in Figs. A-1 through A-12 and B-1 through B-12, respectively.

A comparison of corrected monthly predictions and observations was made, and the error after correction was determined. To show the

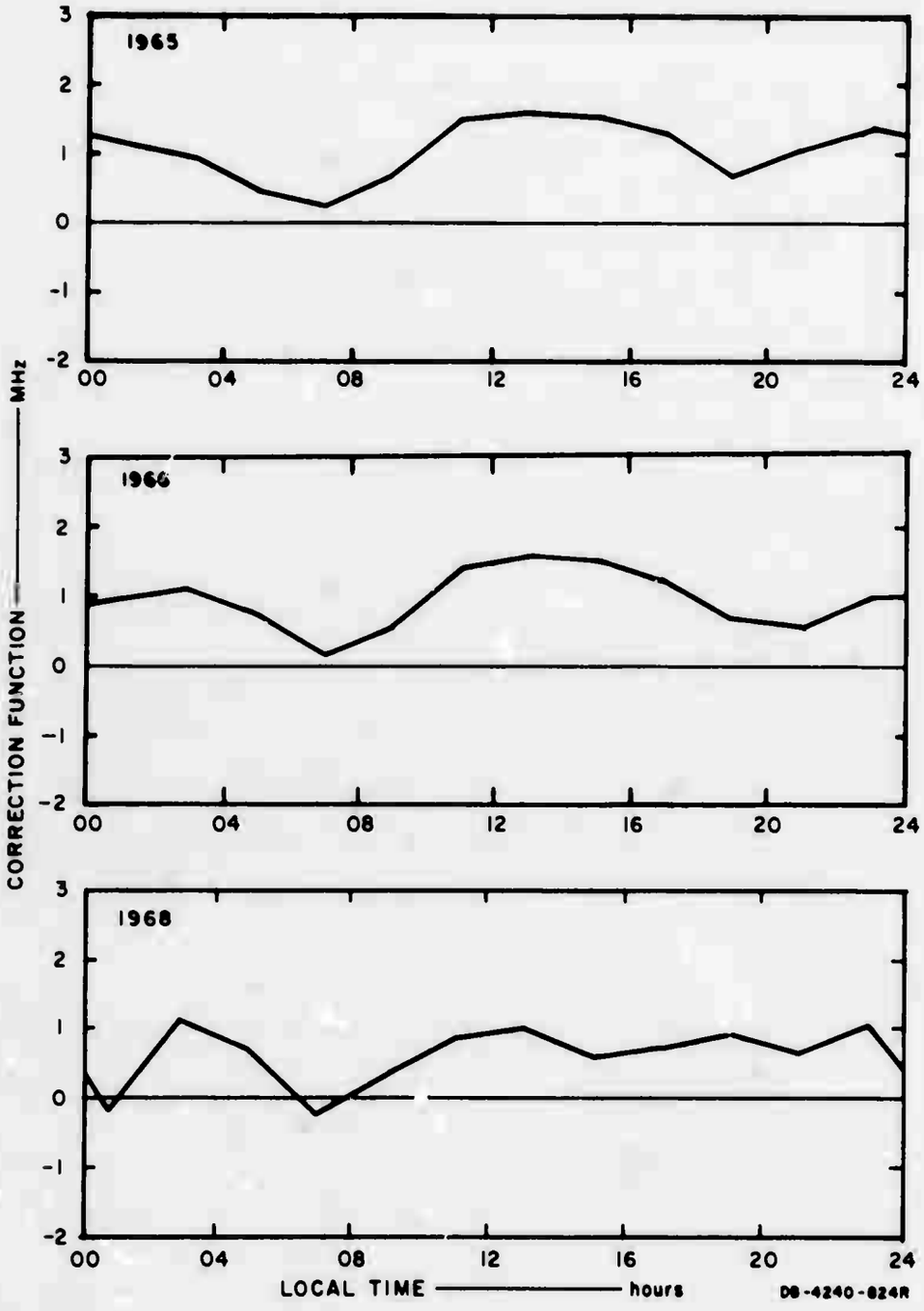

FIG. 16 CORRECTION FUNCTIONS FOR 1965, 1966 AND 1968 ESSA foF2 PREDICTIONS

improvement introduced by the correction function, the prediction errors for both corrected and uncorrected predictions are shown at the bottom of the figures of Appendices A and B. The improvement is summarized in Figs. 17 and 18, where the yearly median errors before and after correction are plotted for 1965 and 1966.

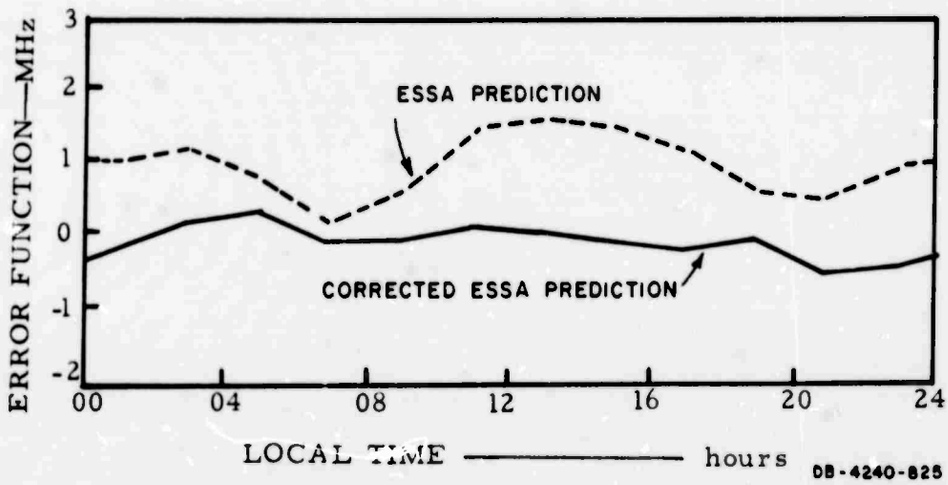

FIG. 17 COMPARISON OF MEDIAN ERROR FUNCTIONS FOR 1965

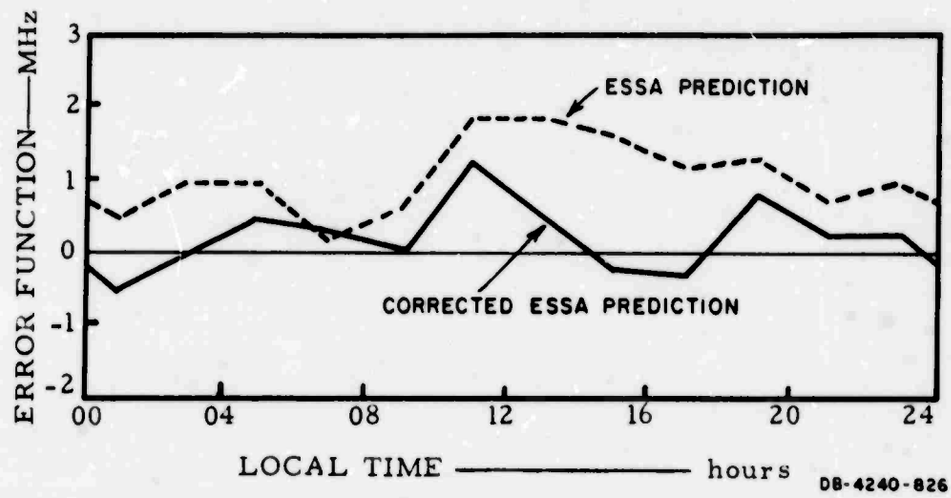

FIG. 18 COMPARISON OF MEDIAN ERROR FUNCTIONS FOR 1966

IV DISCUSSION

Both the uncorrected SRI/RPA and pre-1967 uncorrected ESSA predictions of foF2 suffered from inadequately accounting for the midday dip in foF2 owing to the "equatorial trough" effect in F2-layer electron density. The application of a correction function obtained using F2 critical frequency measurement made at Bangkok to these uncorrected predictions introduced a midday dip quite similar to that observed. The inclusion of Bangkok in the data sources used with 1967 ESSA predictions has probably resulted in predictions that are more accurate during the daytime.

Sufficient data are now available to make possible an evaluation of the several predictions. Corrected SRI/RPA predictions for April 1965-December 1966[5] and January-December 1967 show an offset from zero of the median error of -0.4 MHz and -0.9 MHz respectively, with variation of approximately ±0.5 MHz about the offset. Corrected ESSA predictions for 1965 and 1966 have an average of the median prediction error of 0.2 and 0.5 MHz respectively, while uncorrected (modified) ESSA predictions for 1967 have an average prediction error of 0.5 MHz. In calculating these numbers, the assumption has been made that the critical frequency as measured by the Bangkok C-2 sounder is perfectly accurate. In fact, there is some evidence to indicate that the C-2 measurements were too low at frequencies between 7 and 11 MHz.[22] Measurements made at Bangkok in mid-1966 with a Granger sounder operating in the vertical-incidence mode indicated that the C-2 critical frequencies were about 0.8 MHz lower than the Granger measurements. A similar comparison in mid-1967 showed the C-2 critical frequencies averaged about 0.4 MHz lower than the Granger measurements. Since foF2 was greater than 7 MHz more than 75 percent of the time, the possible error in C-2 data could be significant. For example, the difference in C-2 performance in 1966 and 1967 could account for the difference in offset of the median error of the

SRI/RPA corrected predictions for these periods. Furthermore, if the 1967 measurements actually were 0.4 MHz below the true foF2 on the average, the offset of the median error of the modified ESSA predictions would be nearly zero.

In view of the small uncertainty in sounder data, a small uncertainty in the measurable critical frequency due to ionospheric instability,[23] and the substantial departure of day-to-day values from the monthly median, it appears that both the corrected SRI/RPA and the modified ESSA predictions are adequate for the vicinity of Bangkok. The SRI/RPA prediction uses a data base average over about 30 years and so depends heavily on recently derived corrections for accuracy. By deriving yearly correction functions as done in the previous work,[4],[5] reasonably accurate predictions can be made about a year in advance. These would be useful in long-term planning, such as making frequency assignments. Unlike the long-term SRI/RPA scheme, the modified ESSA predictions incorporate recent information about specific localities (including Bangkok C-2 data for predictions beginning January 1967). These shorter-term predictions are expected to be fairly accurate, especially for Bangkok after 1966. The predictions are published monthly and have a three-month lead time. Since no correction to the published data is required, these predictions would be useful for short-term applications, such as specifying which of several assigned frequencies should be tried first at a given time of day on a given path.

Studies in Thailand have shown that predictions for Bangkok are valid for locations within a 200-mile radius of that city.[22],[24] Other studies of the latitudinal variation of F2 critical frequency in Thailand have indicated that the Bangkok predictions could be modified by a latitude correction factor based upon Faraday-rotation data to give improved predictions for any part of Thailand at any time of day.[25] One could use the C-2 data from Bangkok[8] to generate predictions for Bangkok*

*Major Termpoon Kovattana, Royal Thai Air Force, used a point-slope technique to make such predictions, and the agreement with subsequent C-2 measurements at Bangkok was quite good.[26]

and extrapolate these predictions to other parts of the country, using rules inferred from the beacon satellite data.[25] In this manner, frequency predictions of F2 critical frequency (foF2) for any part of Thailand could be made from data gathered by equipment currently operating in the country. It should be emphasized, however, that the ESSA predictions currently available are made for all latitudes and longitudes, and--so long as they remain available (and reasonably accurate, as determined by periodic checks against the Bangkok C-2 data)--it should not be necessary to use extrapolations of Bangkok data or predictions in order to obtain predictions for locations in Thailand remote from Bangkok.

V RECOMMENDATIONS

It is recommended that the regular monthly modified ESSA predictions (for the latitude and longitude of interest) be used within Thailand without correction during 1968.

It is further recommended that these modified ESSA predictions for Bangkok during 1968 be compared with Bangkok C-2 measurements and that an error function be derived to check the accuracy of these predictions and to determine if a correction function seems necessary for 1969 modified ESSA predictions.

The ESSA local-area predictions for Southeast Asia for 1968 also should be checked against the Bangkok C-2 data for the same period. This would permit the usefulness of these predictions (for occasions when greater prediction accuracy is required) to be evaluated.

Finally, the semimonthly revision factors could be applied to the monthly predictions for Bangkok and the result checked against Bangkok C-2 data to permit evaluation of the appropriateness of the use of these revision factors in Thailand.

Appendix A

ESSA PREDICTION EFFECTIVENESS--1965

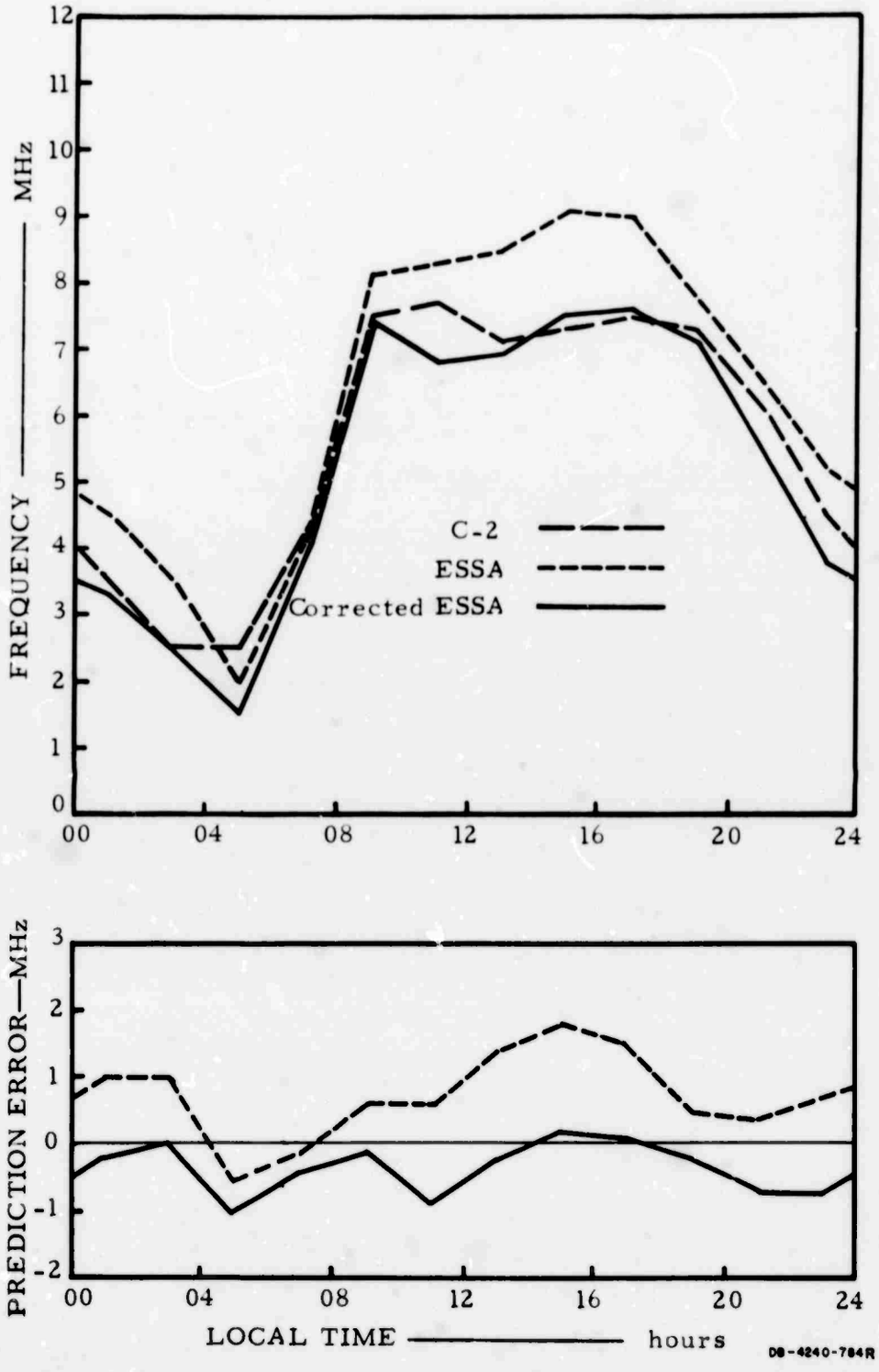

FIG. A-1 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR JANUARY 1965

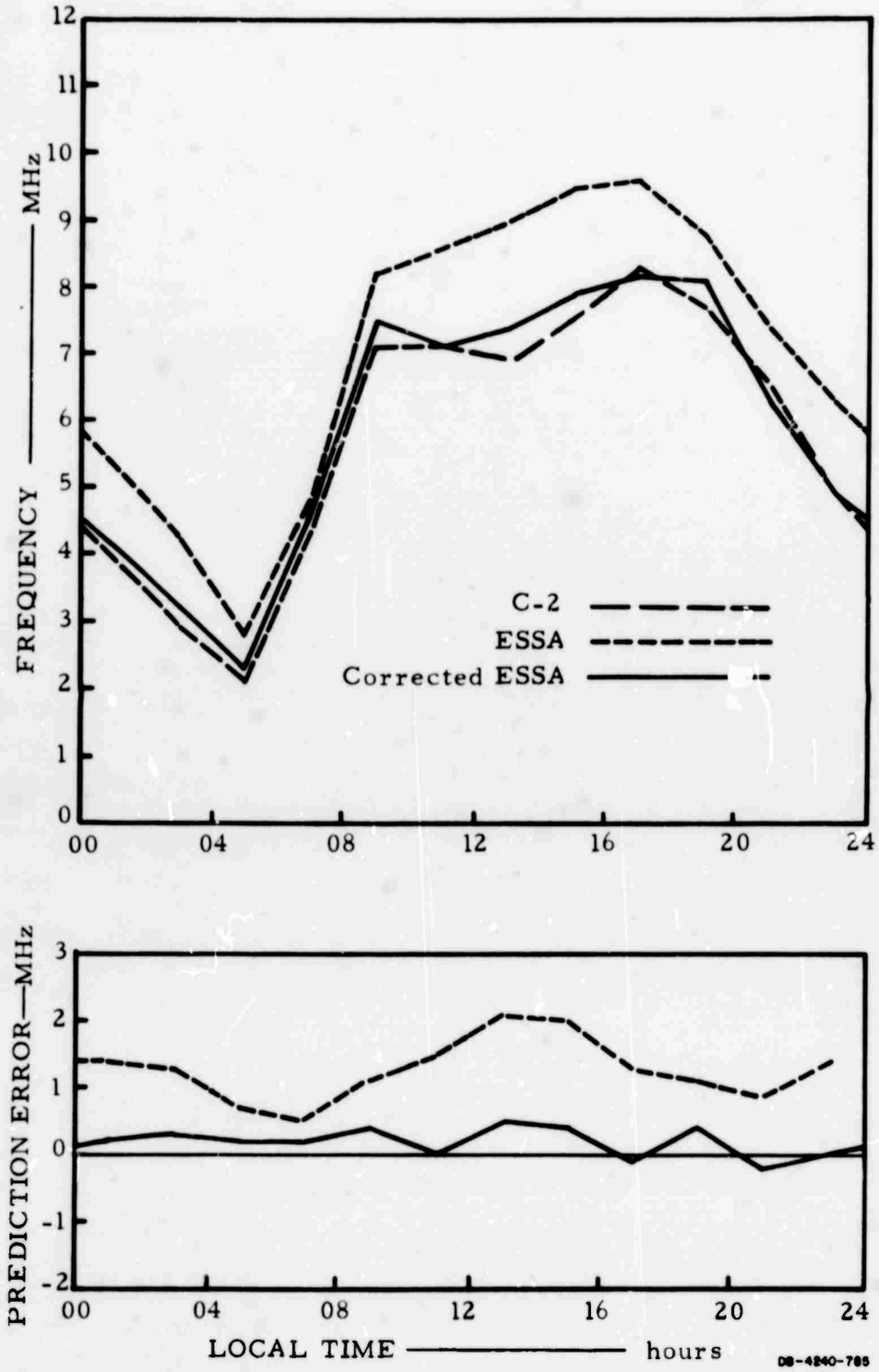

FIG. A-2 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR FEBRUARY 1965

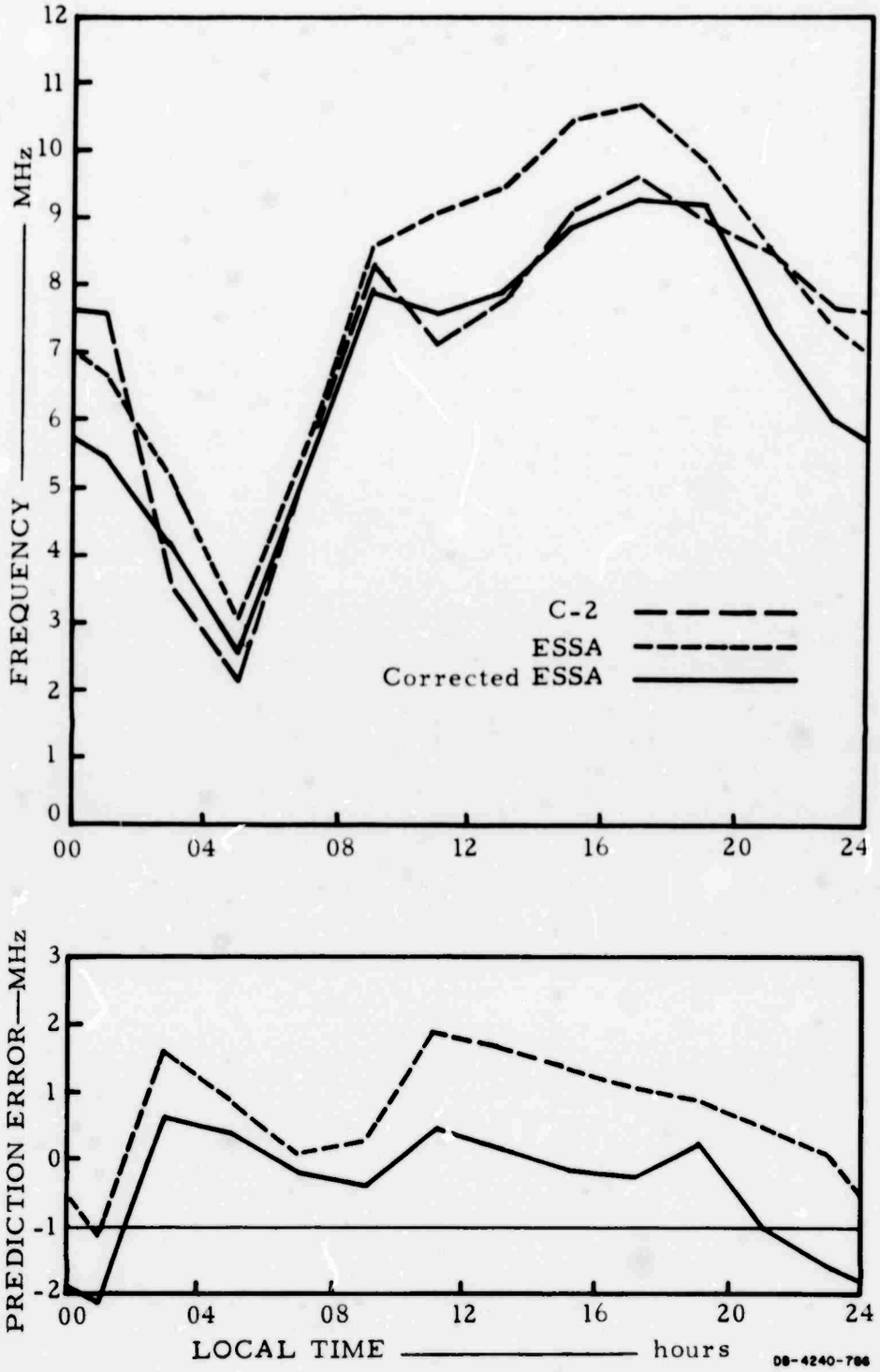

FIG. A-3 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR MARCH 1965

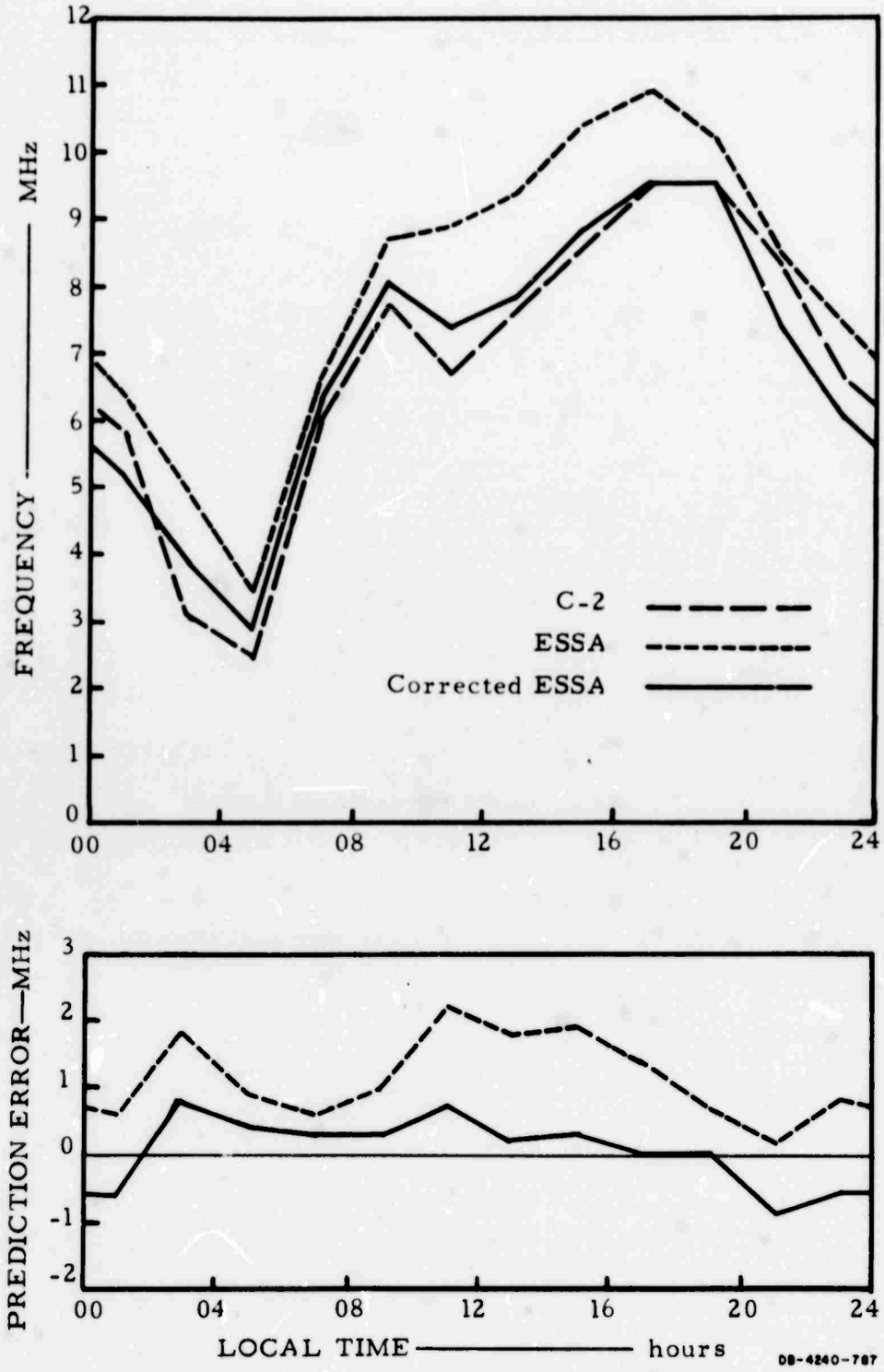

FIG. A-4 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR APRIL 1965

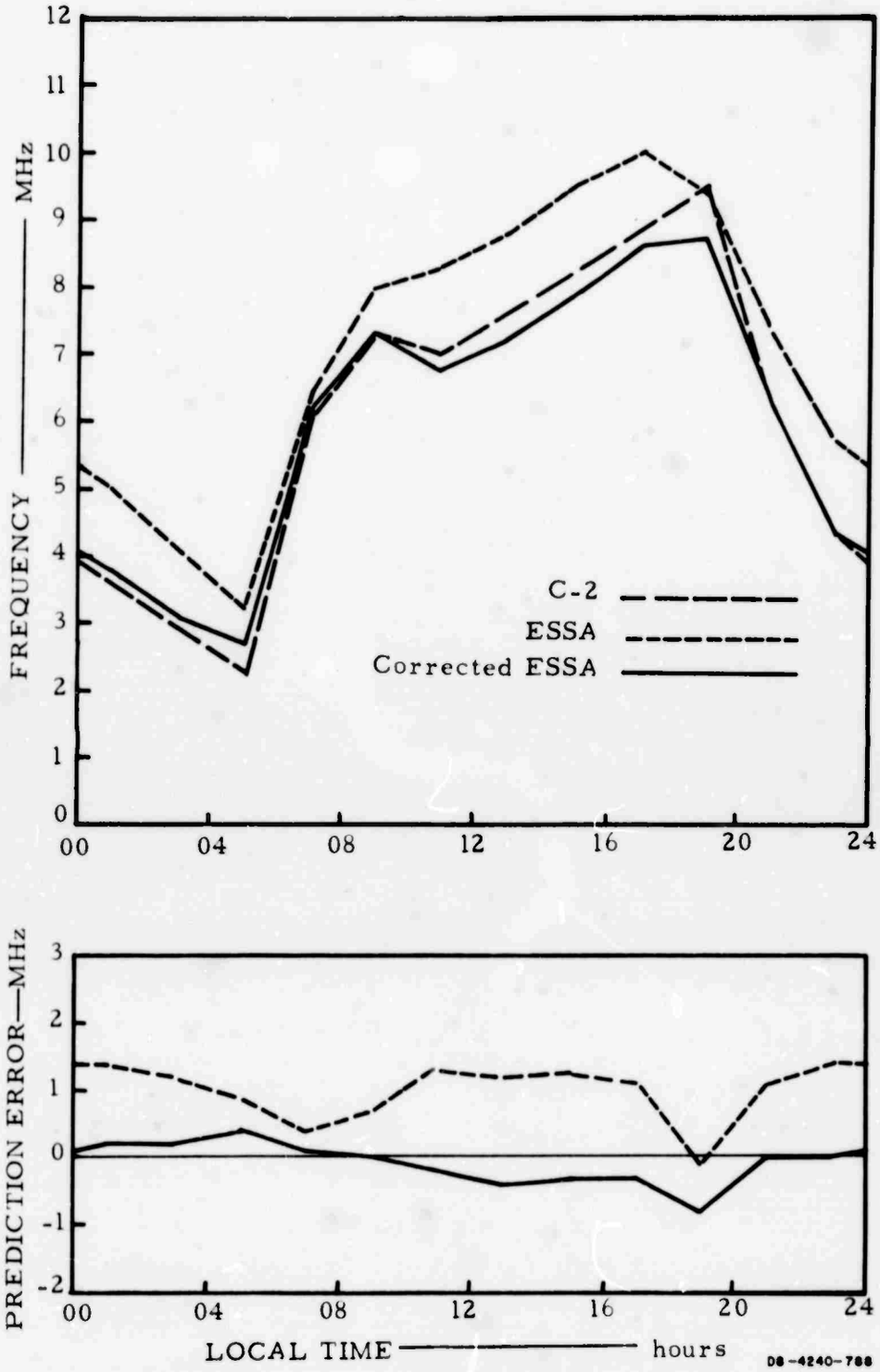

FIG. A-5 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR MAY 1965

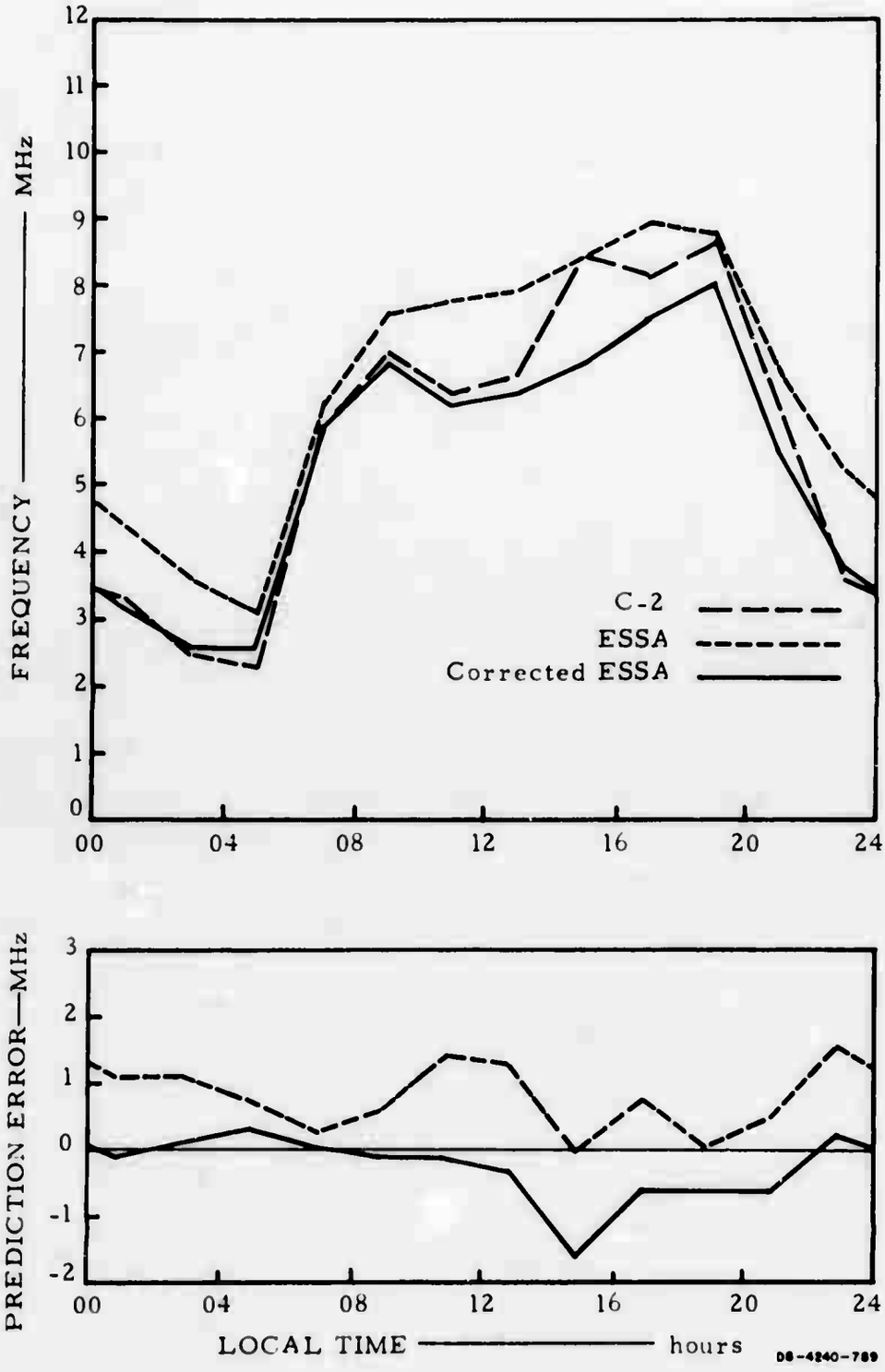

FIG. A-6 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR JUNE 1965

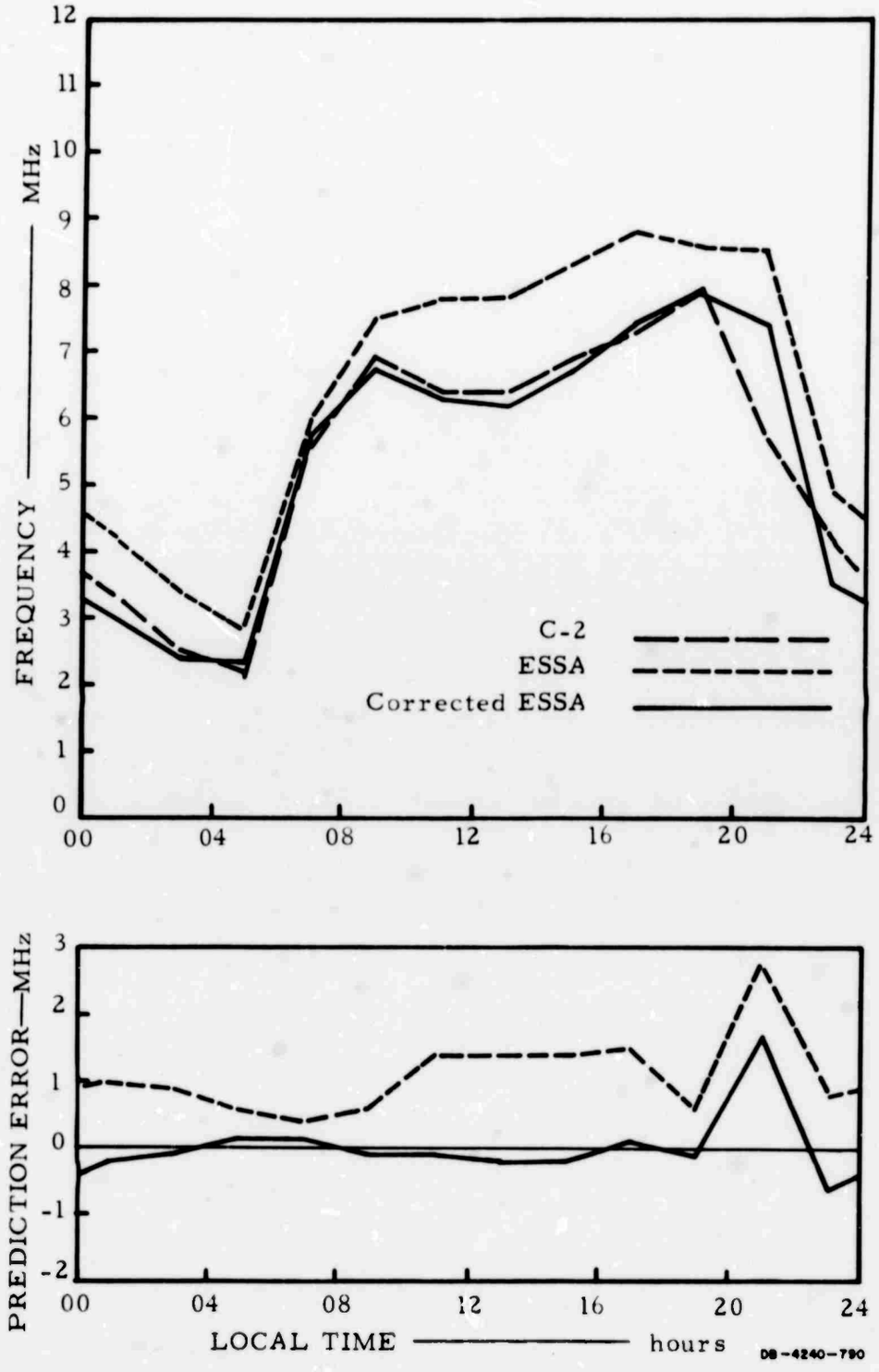

FIG. A-7 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR JULY 1965

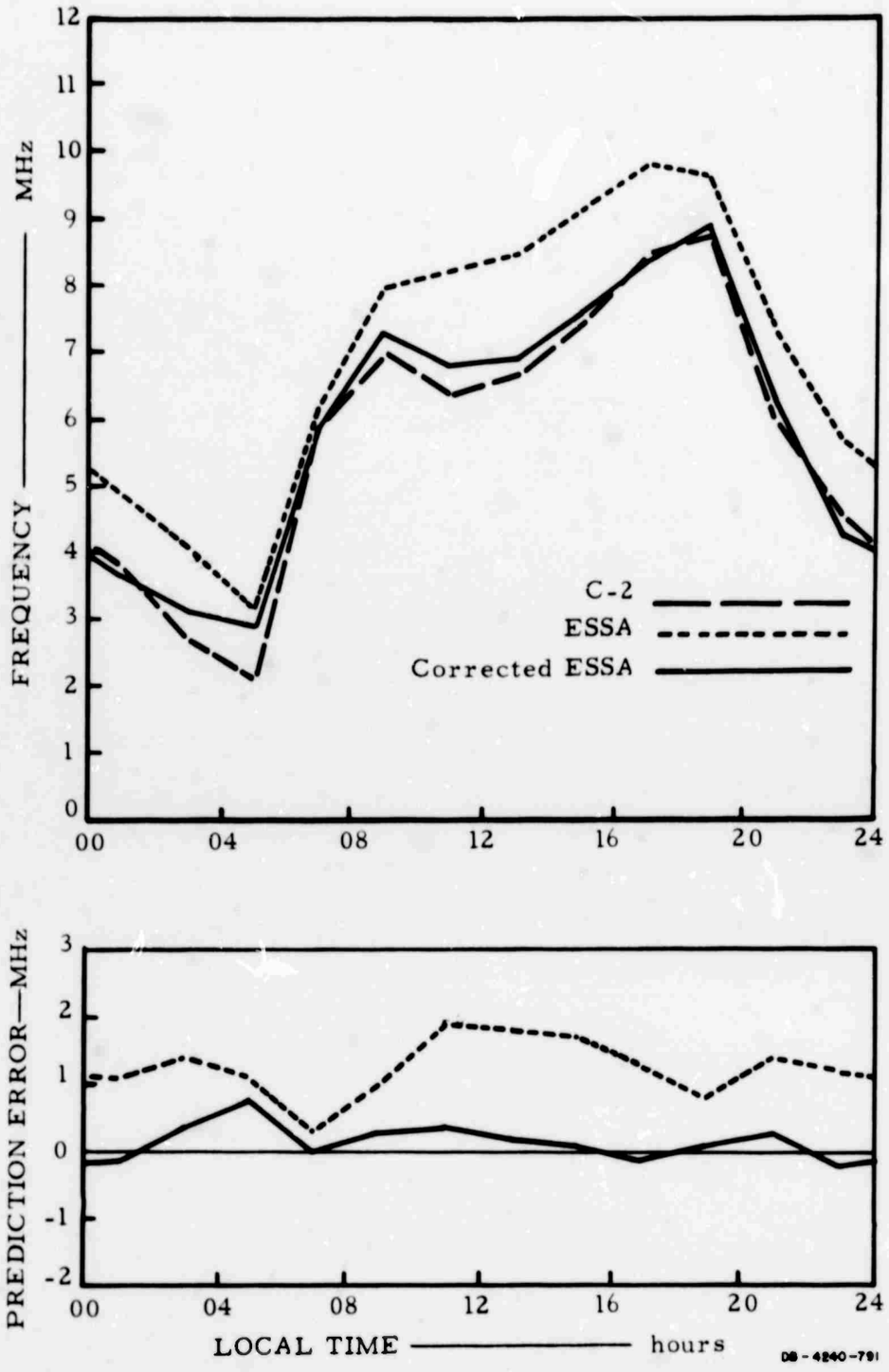

FIG. A-8 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR AUGUST 1965

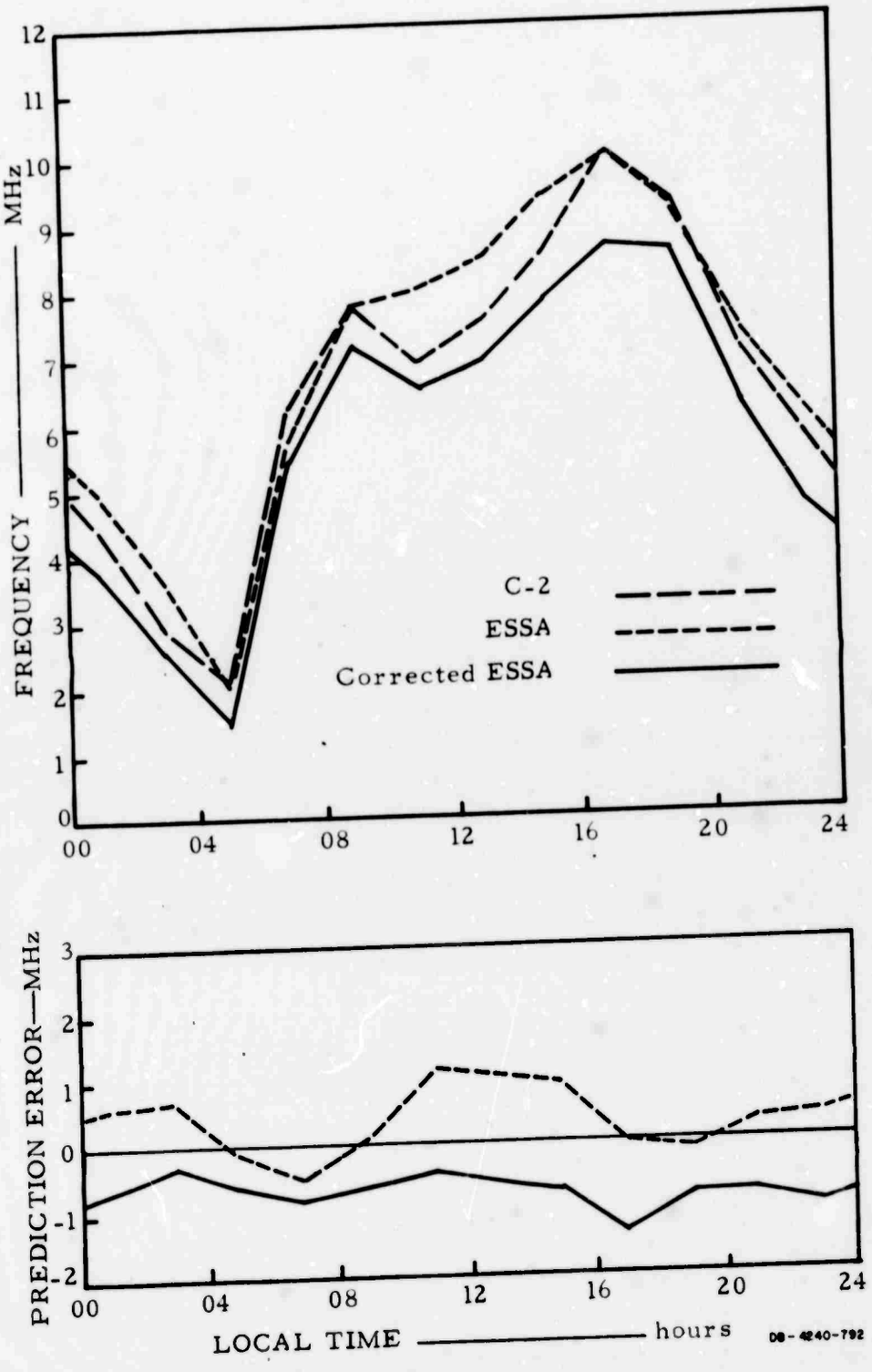

FIG. A-9 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR SEPTEMBER 1965

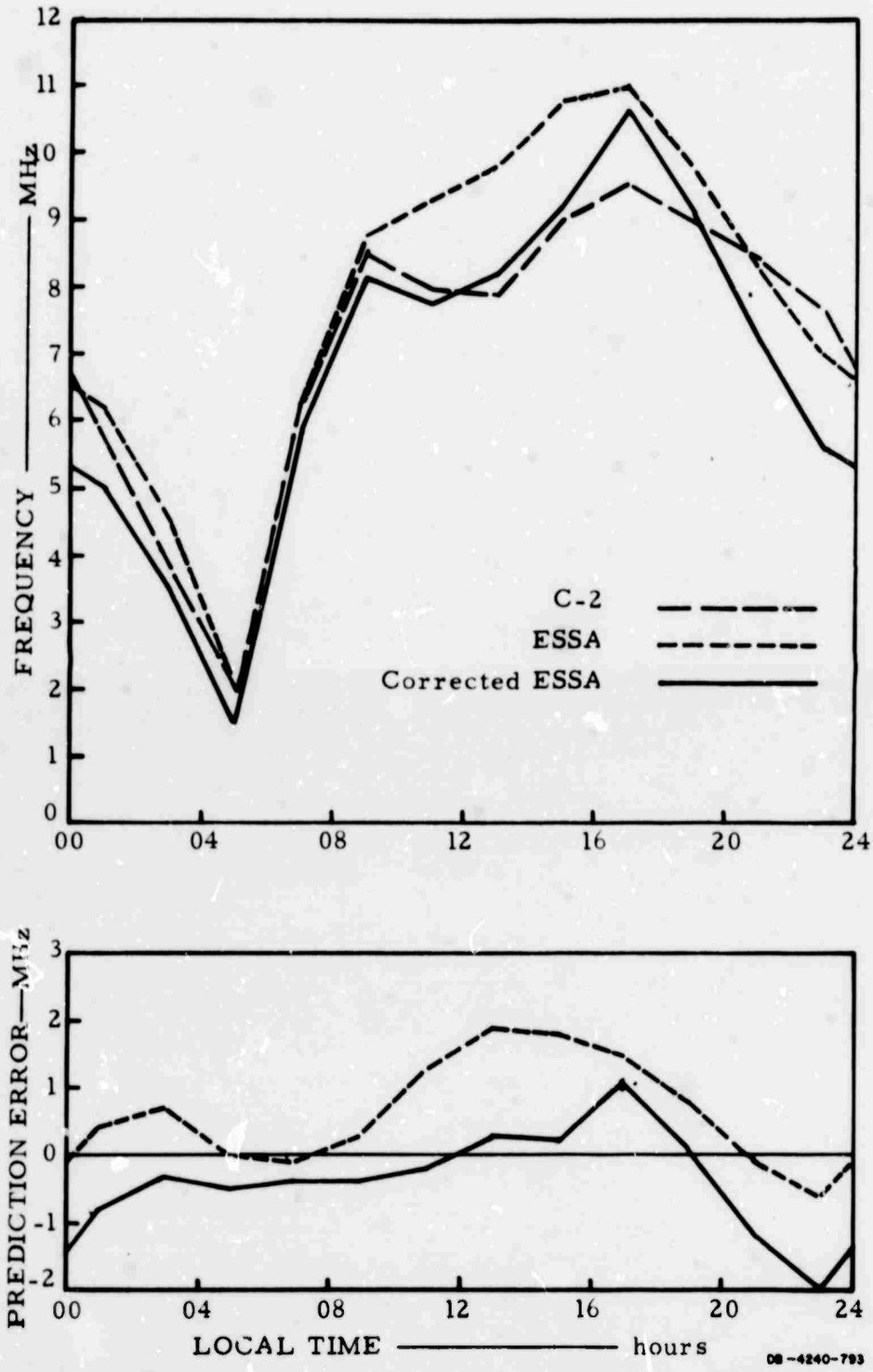

FIG. A-10 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR OCTOBER 1965

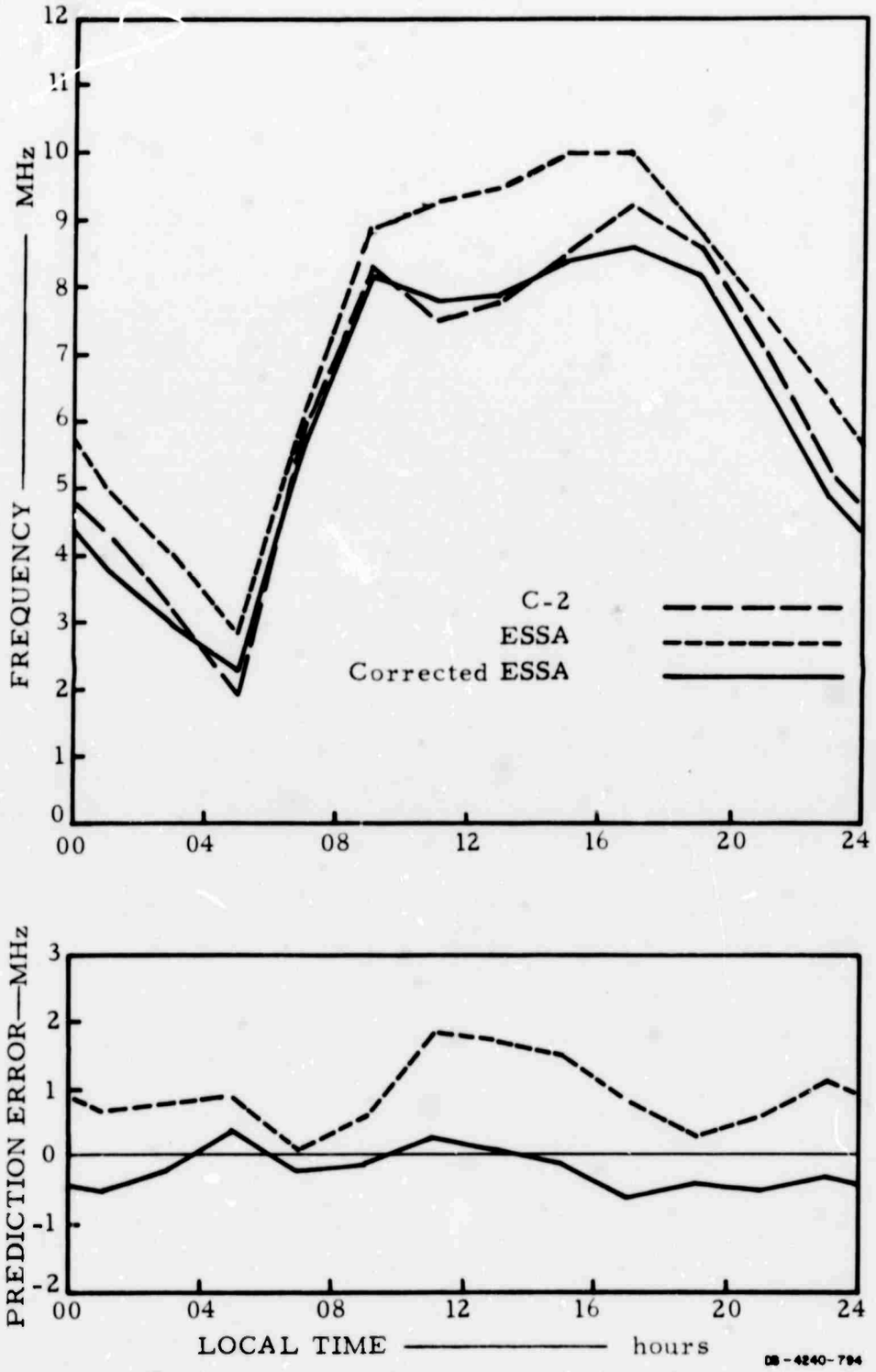

FIG. A-11 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR NOVEMBER 1965

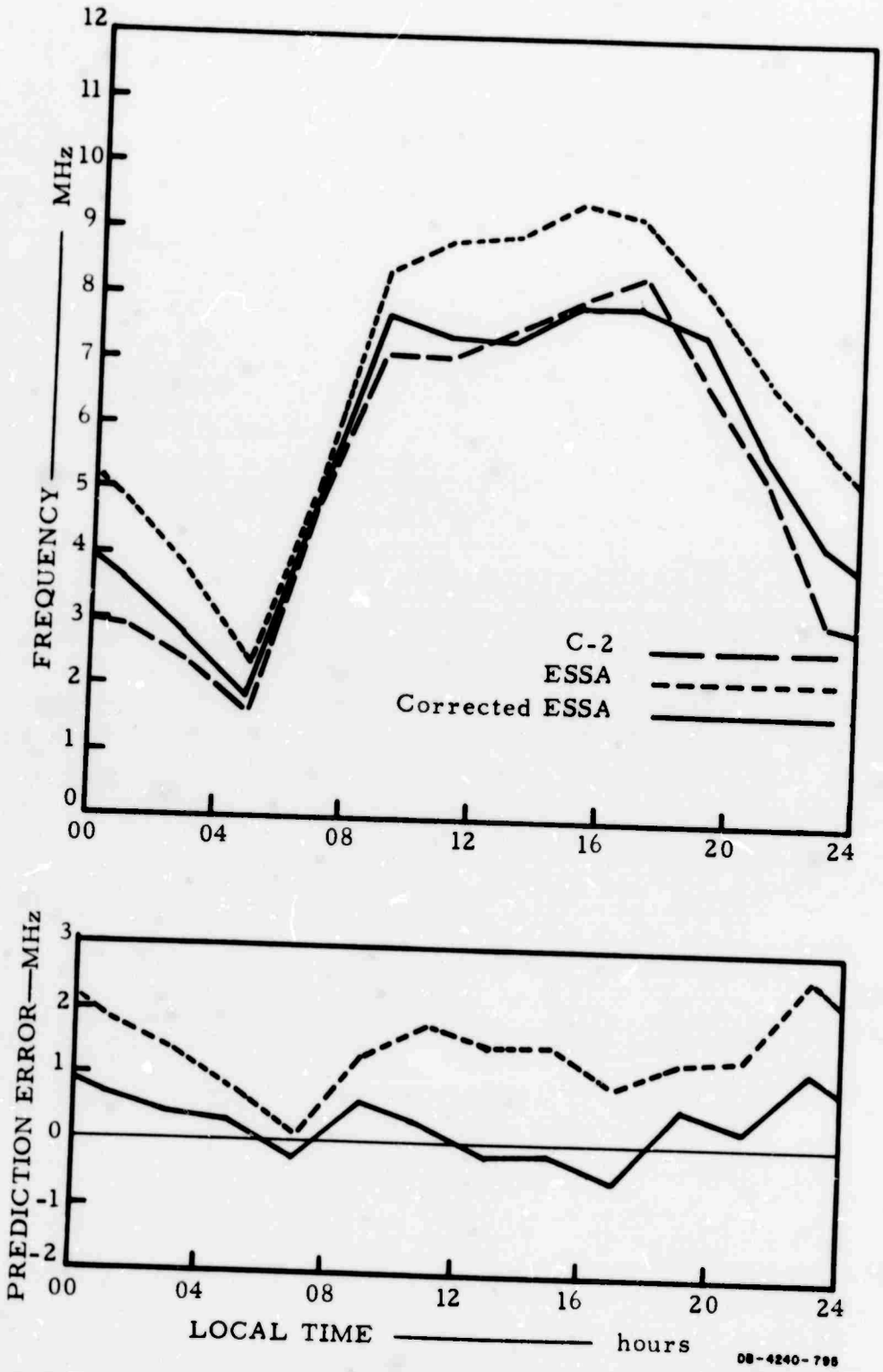

FIG. A-12 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR DECEMBER 1965

Appendix B

ESSA PREDICTION EFFECTIVENESS--1966

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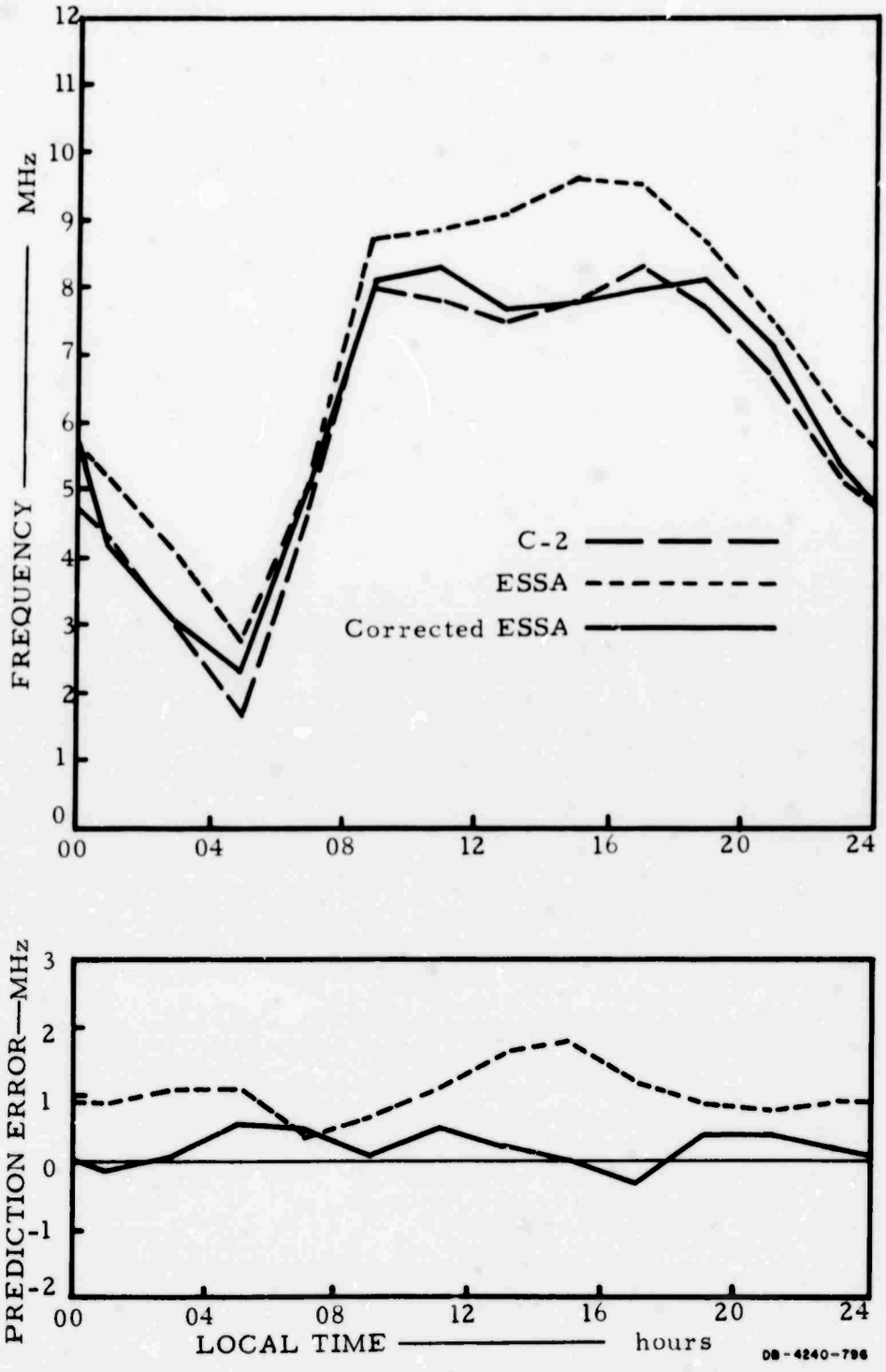

FIG. B-1 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR JANUARY 1966

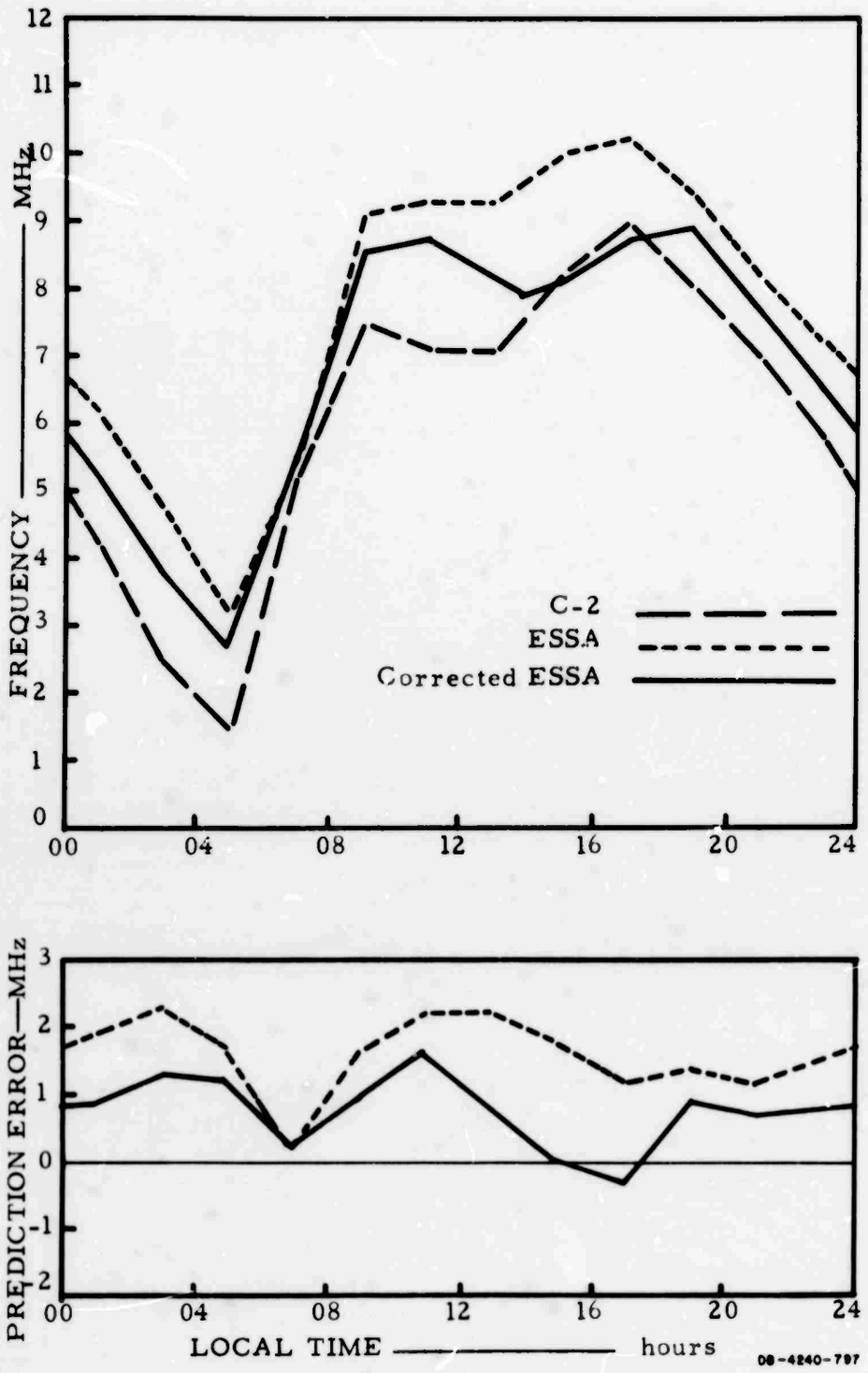

FIG. B-2 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR FEBRUARY 1966

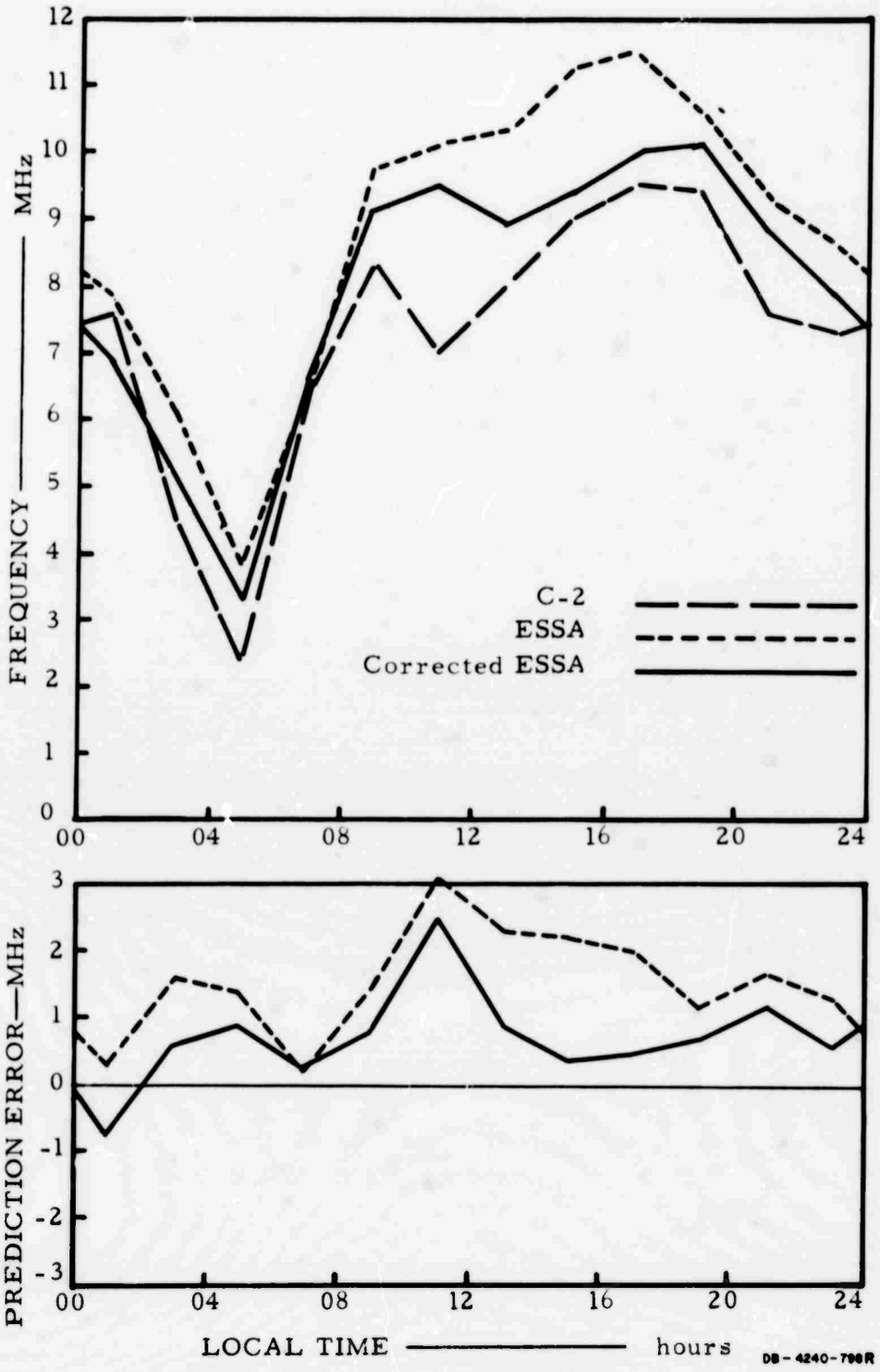

FIG. B-3 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR MARCH 1966

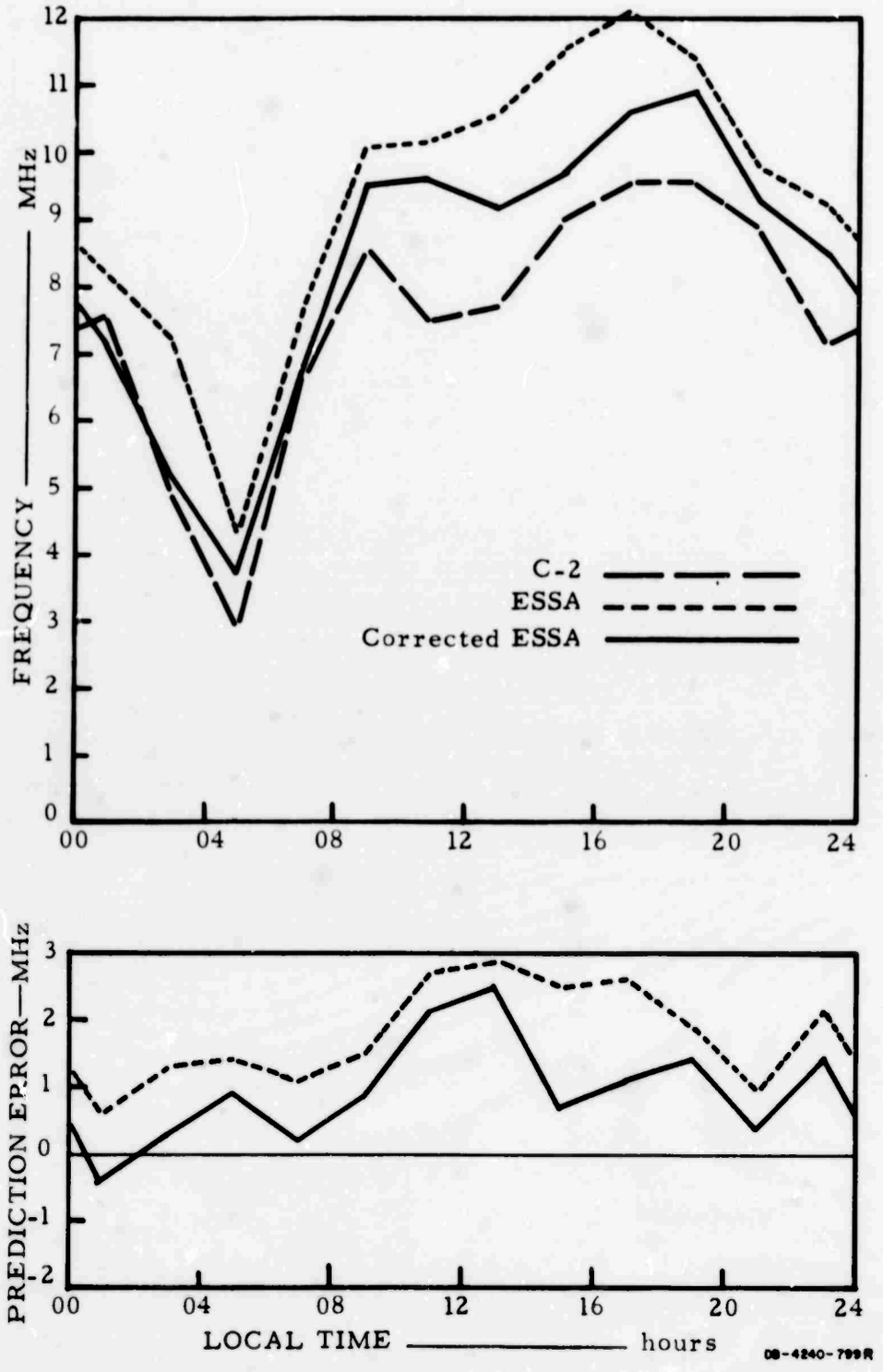

FIG. B-4 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR APRIL 1966

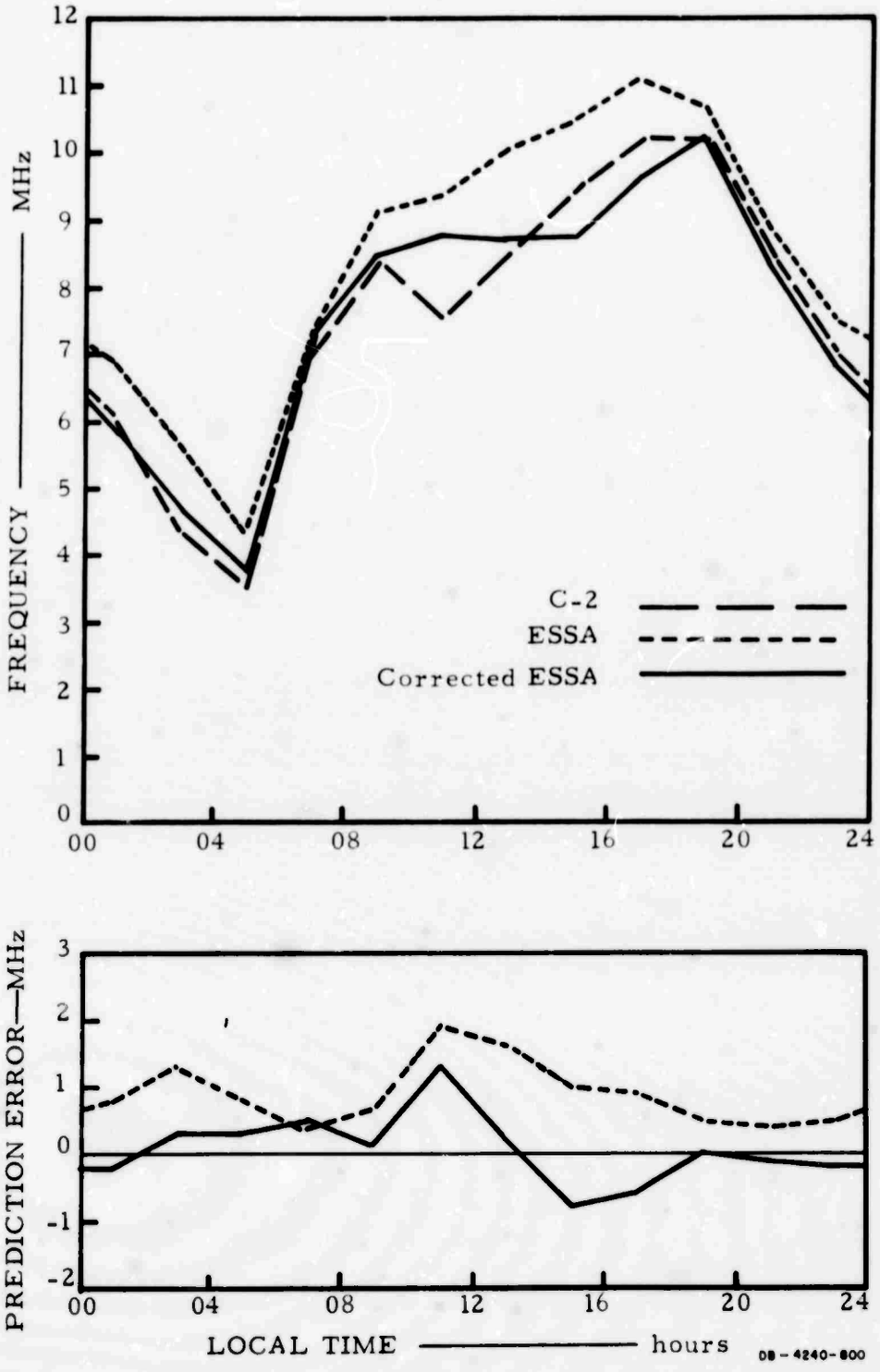

FIG. B-5 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR MAY 1966

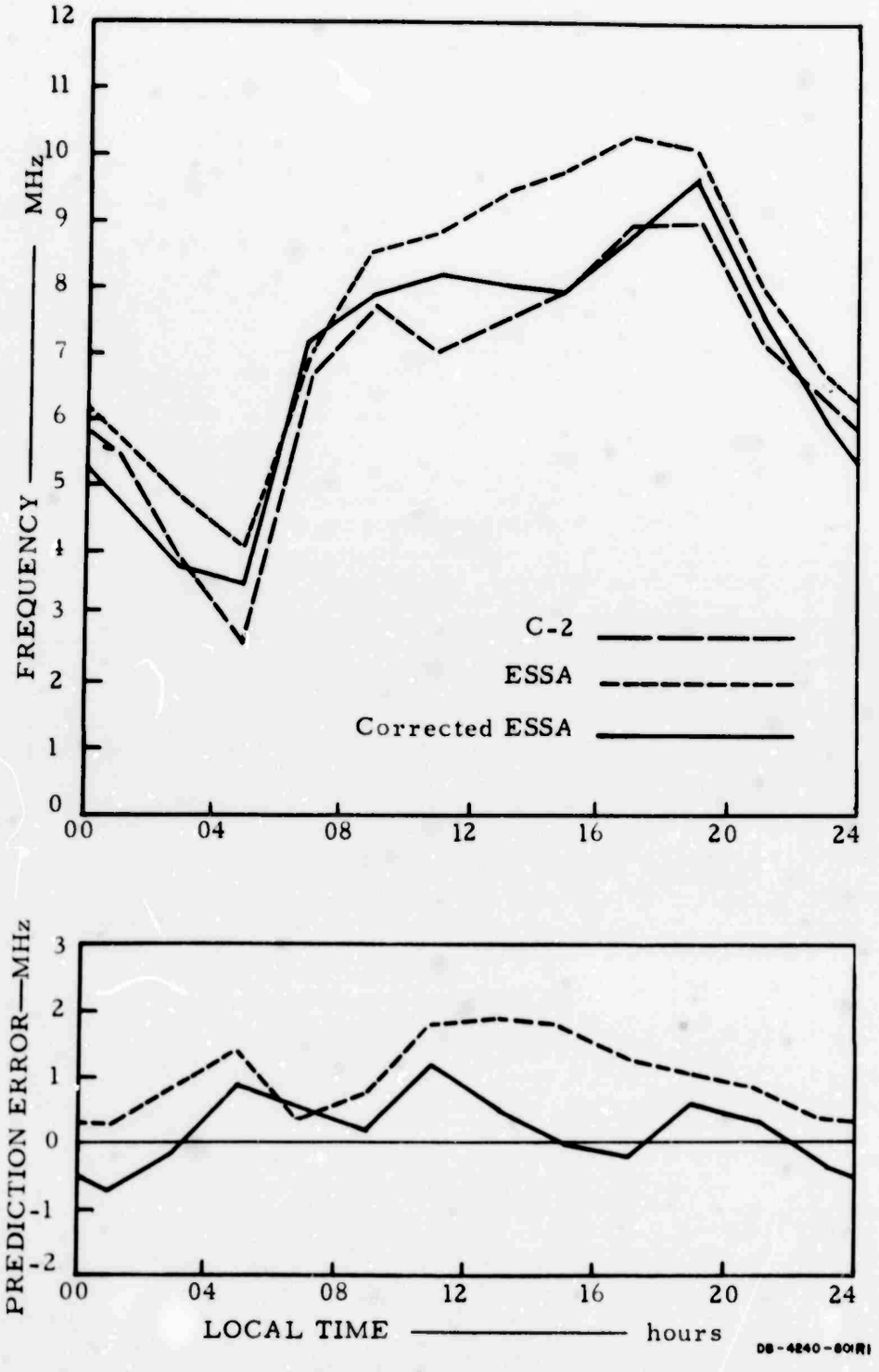

FIG. B-6 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR JUNE 1966

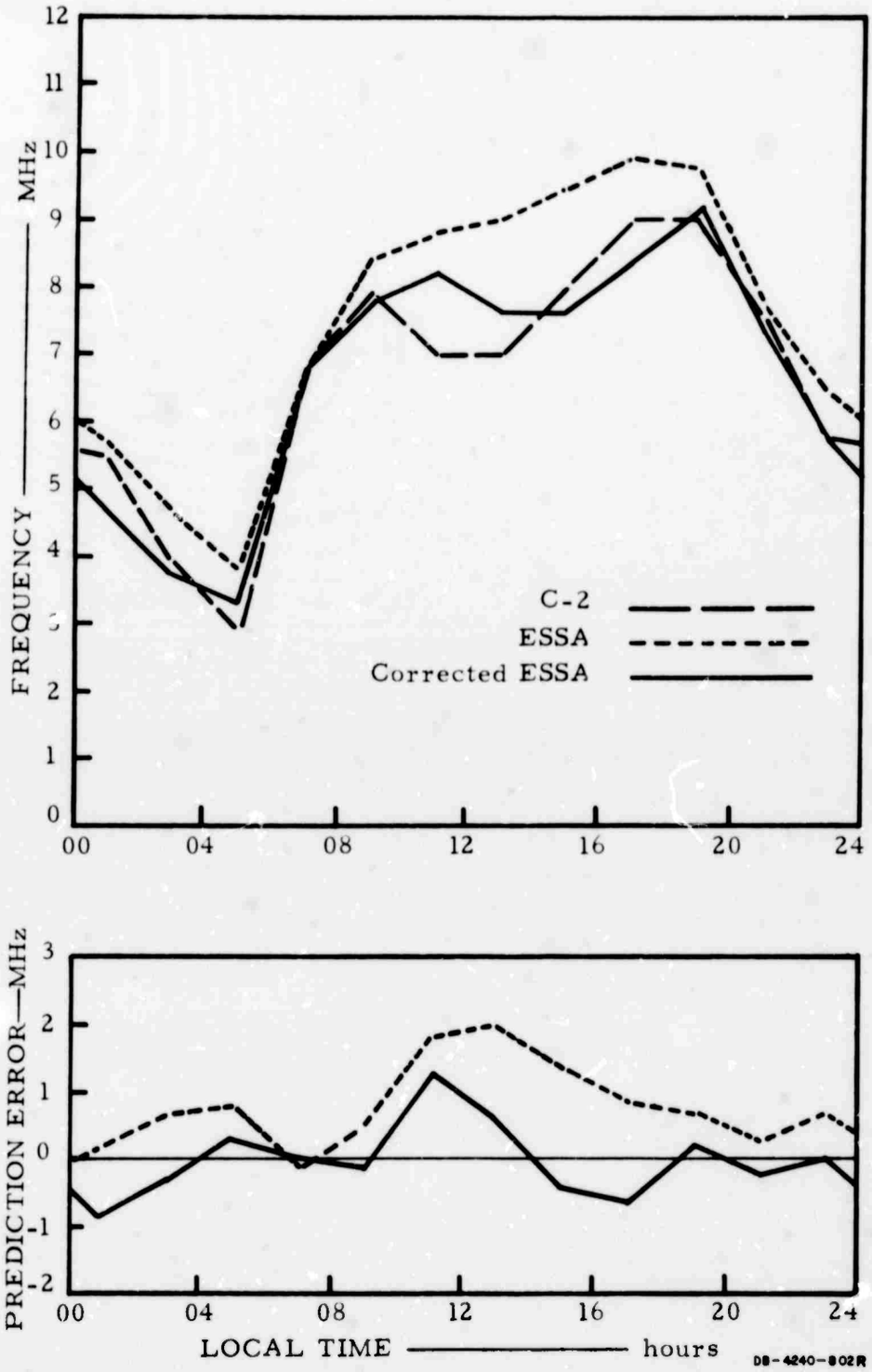

FIG. B-7 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR JULY 1966

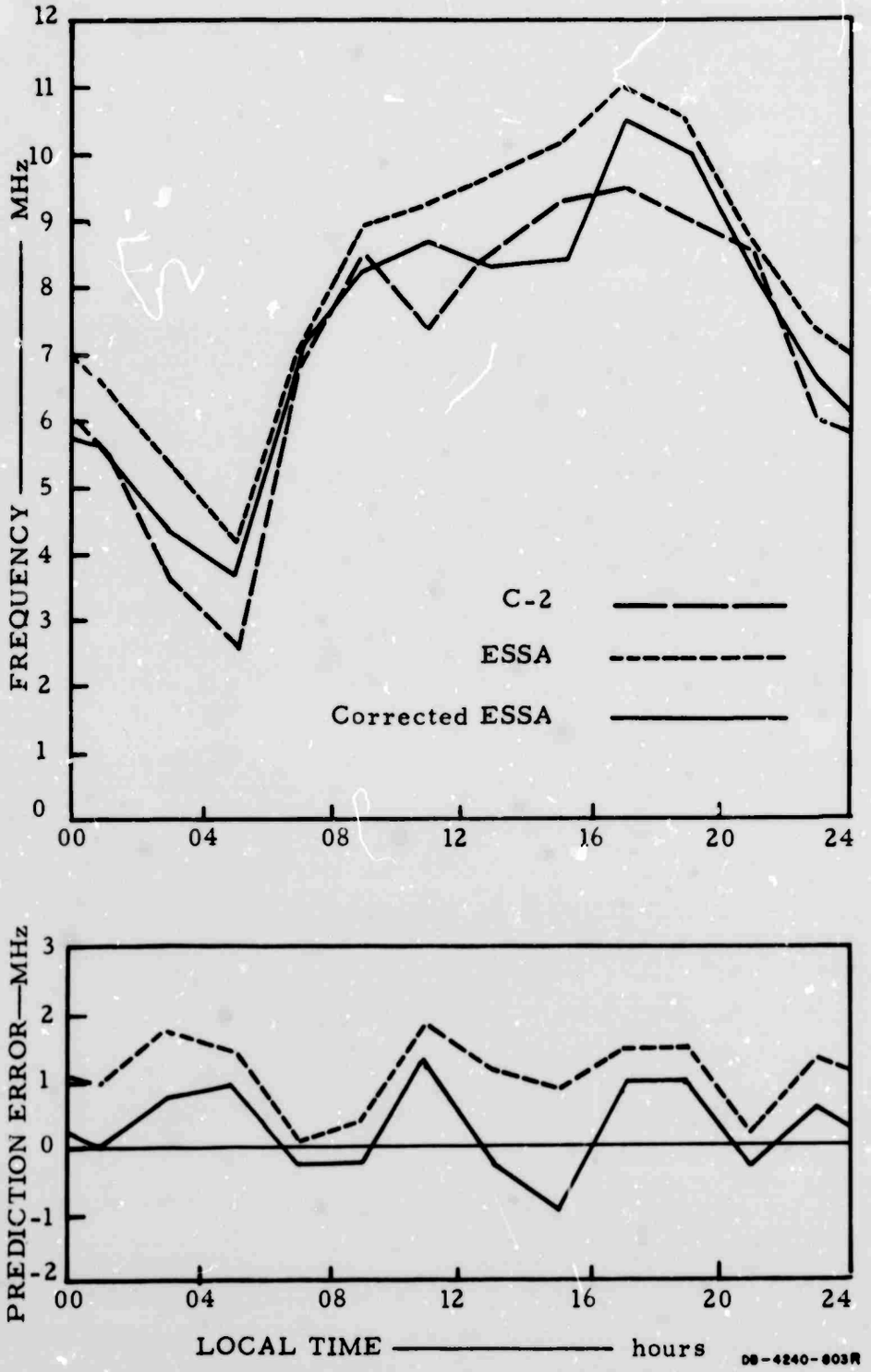

FIG. B-8 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR AUGUST 1966

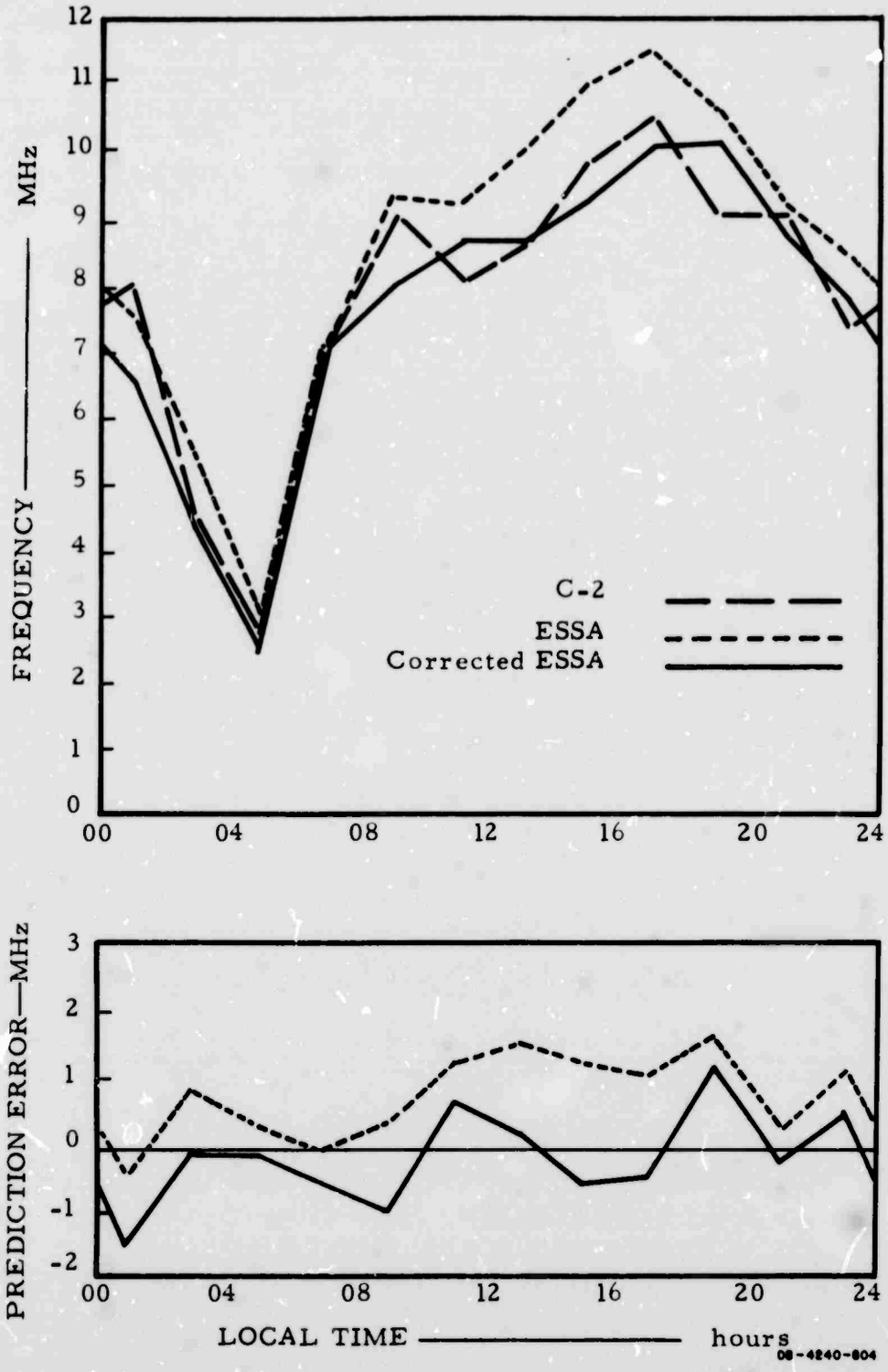

FIG. B-9 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR SEPTEMBER 1966

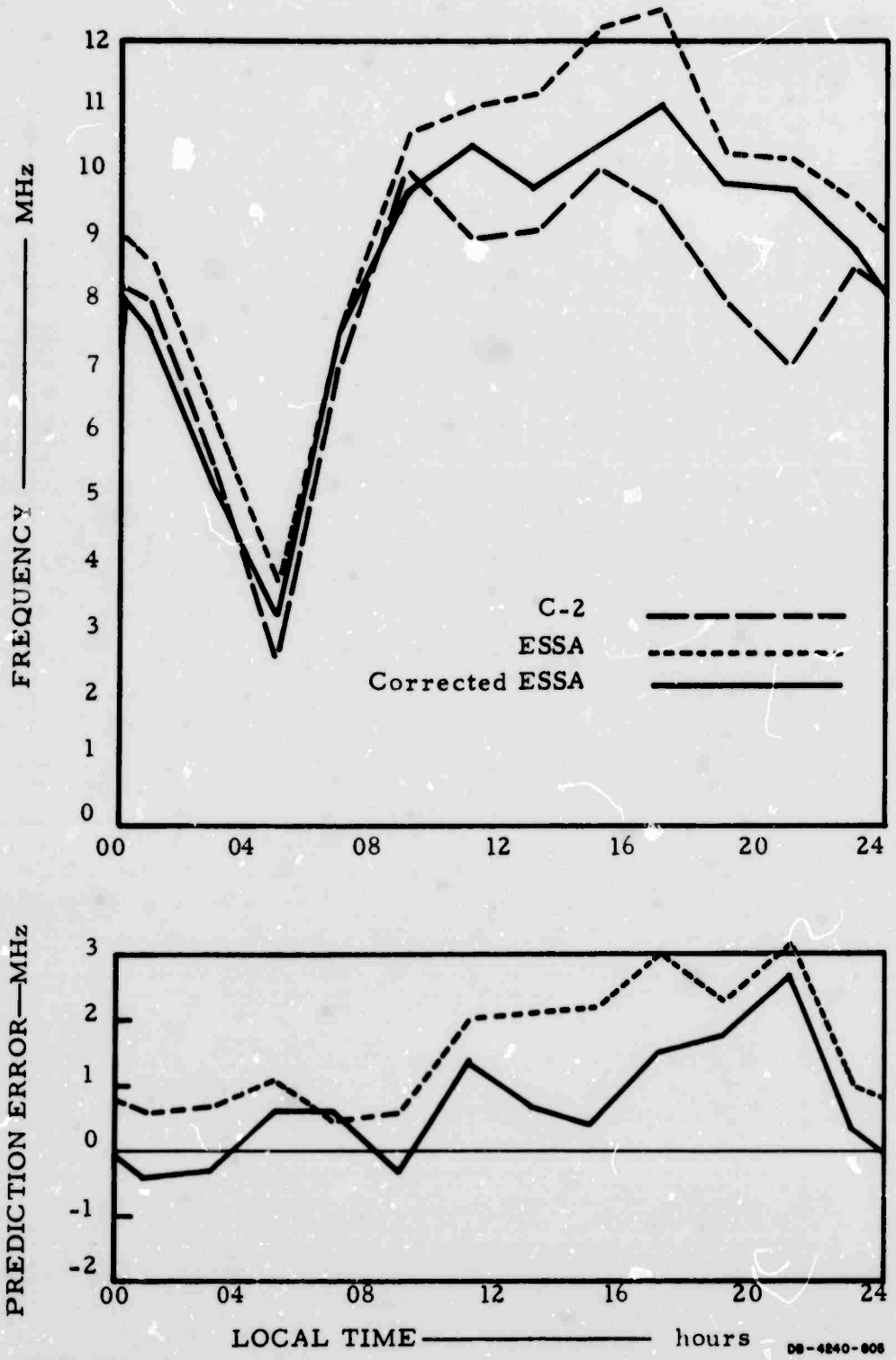

FIG. B-10 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR OCTOBER 1966

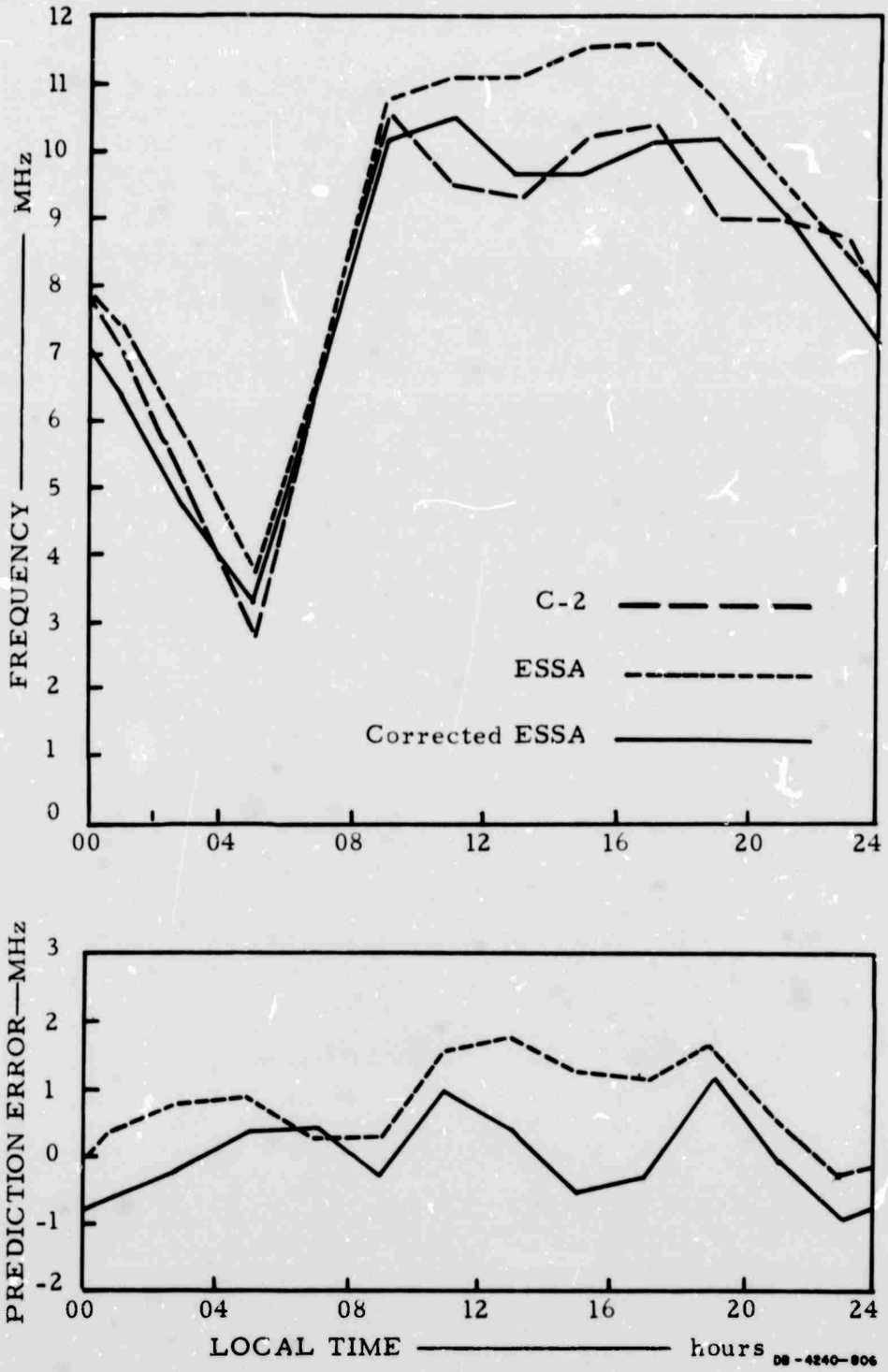

FIG. B-11 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 FOR NOVEMBER 1966

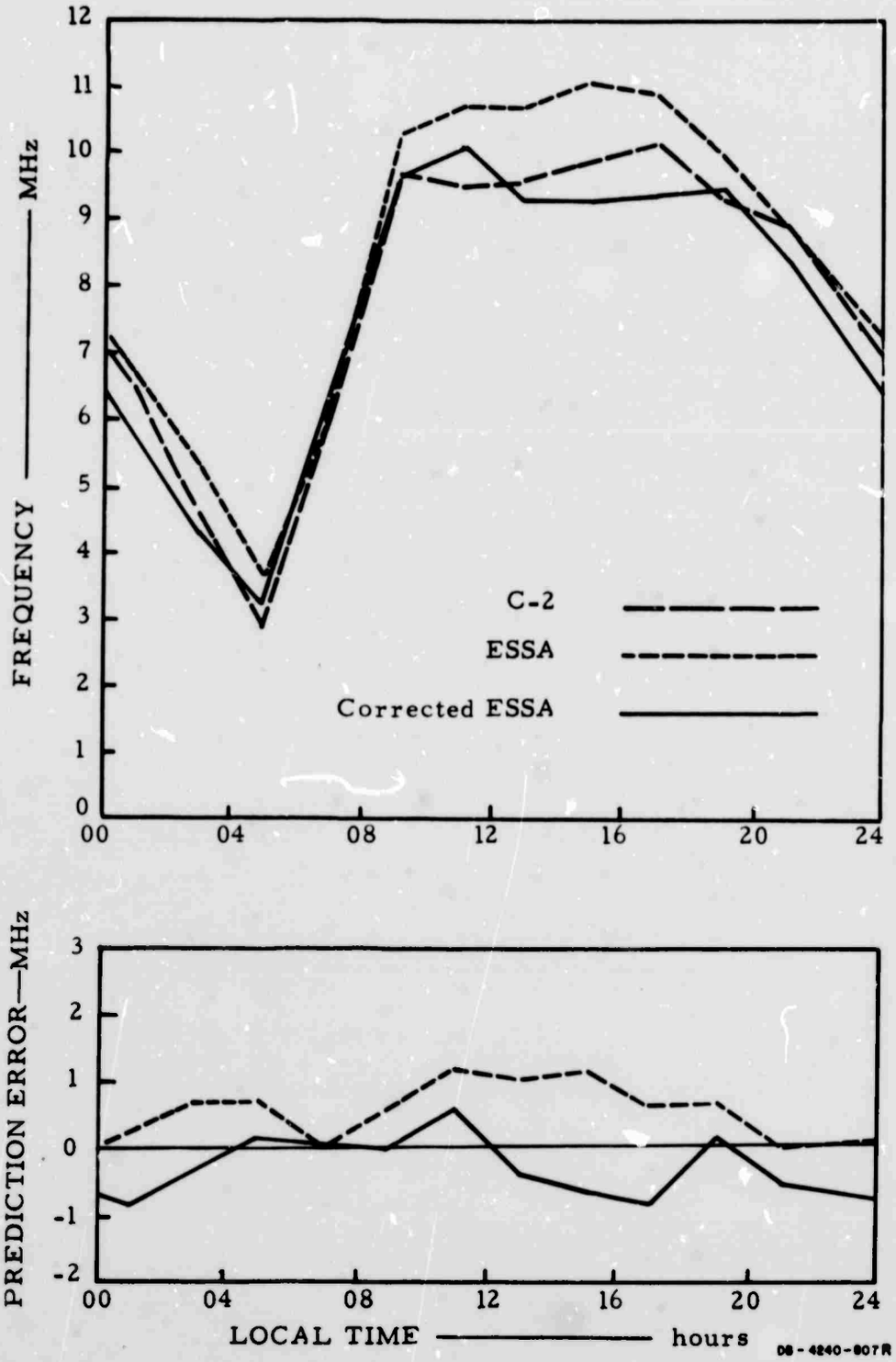

FIG. B-12 COMPARISON OF OBSERVED AND ESSA-PREDICTED MONTHLY MEDIAN foF2 for DECEMBER 1966

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13 ABSTRACT

Predictions derived by two methods for estimating F-layer critical frequency are evaluated by comparing 1967 predictions and measurements for Bangkok. One set of predictions has been obtained from a program developed at SRI (SRI/RPA predictions); the other has been obtained by scaling prediction contour maps prepared by ESSA. The SRI/RPA predictions have been corrected to take into account the error in prediction during 1966 compared to measurements at Bangkok, but because of a modification in ESSA predictions, including those for Southeast Asia, no local correction has been applied to 1967 ESSA predictions. Thus, for 1967 corrected SRI/RPA and uncorrected modified ESSA predictions are evaluated. The evaluation shows that the average error of both predictions of foF2 relative to ionosonde measurements is less than 1 MHz. The modified ESSA predictions are somewhat more accurate, averaging about 0.5 MHz higher than the observed median foF2 values.

A comparison of uncorrected modified ESSA predictions for 1967 and ESSA predictions for previous years shows a definite improvement in accuracy of these uncorrected modified ESSA predictions relative to the uncorrected predictions made prior to 1967. Based on 1967 results, it is expected that future uncorrected ESSA predictions will be at least as accurate as SRI/RPA predictions that have been corrected using local Bangkok C-2 data. Furthermore, the anticipated error in uncorrected ESSA predictions (about 0.5 MHz average) is not serious enough to warrant applying a local correction for the vicinity of Bangkok. Consequently, the 3-month-term ESSA predictions would be preferred for Thailand.

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Frequency predictions						
ESSA predictions						
SRI/RPA predictions						
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F2 layer						
foF2						
Critical frequency						
Prediction correction function						
Statistical evaluation						
Prediction effectiveness 1964 through 1967						
Bangkok						
Thailand						
SEACORE						